Pedestrian and Bicycle Master Plan

Town of Hanover, New Hampshire

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Pedestrian and Bicycle Master Plan

Table of Contents

1. Introduction 1-1
- Purpose of the Master Plan.....1-1
- The Benefits of Walking and Bicycling.....1-1
- Pedestrian and Bicyclist Planning Goals 1-2
- Factors that Influence Walking and Bicycling.....1-3
- Plan Area 1-4
- Walking and Bicycling in Hanover.....1-4

2. Pedestrians.....2-1
- New Hampshire State Statutes.....2-1
- Characteristics of Pedestrian Friendly Streets.....2-2

3. Bicycles.....3-1
- New Hampshire State Statutes and Town Laws.....3-1
- Encouraging Bicycling as a Mode of Transportation.....3-2
- Types of Bicycle Facilities 3-3

4. Plan Recommendations 4-1
- The Pedestrian and Bicycle Network.....4-1
- Downtown and Central Campus Area 4-2
- Dresden Village / Lyme Road Area 4-12
- Greensboro Road / Route 120 Area.....4-14

List of Figures

Figure 1: Plan Area 1-4
Figure 2: Pedestrian and Bicycle Accidents.....1-8
Figure 3: The Relationship between Speed and Pedestrian Fatalities.....2-4
Figure 4: Spatial Dimensions for Pedestrians.....2-5
Figure 5: Four Types of Transportation Cyclists.....3-2
Figure 6: Recommended Pedestrian Improvements.....4-2
Figure 7: Conceptual Plan Central Hanover 4-4
Figure 8: Bicycle Master Plan.....4-7
Figure 9: Bicycle Master Plan - Downtown Area 4-9
Figure 10: Bicycle Master Plan - Dresden Village Area 4-10
Figure 11: Conceptual Plan for Reservoir Road Area.....4-11
Figure 12: Conceptual Plan for Greensboro Road / Route 120.....4-15

List of Tables

Table 1: Recommendations for Crosswalks at Uncontrolled Locations.....2-8
Table 2: Sample Bike Parking Requirements 4-20

Pedestrians on South Main Street in the downtown.

Introduction

"An early morning walk is a blessing for the whole day."
-Henry David Thoreau

Purpose of the Master Plan

This is the first master plan for pedestrian and bicycle circulation that has been developed for the Town of Hanover. The plan has been developed in order to:

- identify policies to make walking and bicycling in Hanover safer, easier and more attractive;
- identify standards and guidelines for pedestrian and bicycle facility design;
- provide an action plan for future improvements to the bicycle and pedestrian network;
- outline steps to promote walking and bicycling in Hanover as an alternative to driving.

The Benefits of Walking and Bicycling

There are a number of reasons to promote walking and bicycling in Hanover:

Improved Mobility. Walking and bicycling provides an alternative means for travel beyond driving. Most trips begin and end as pedestrian trips. Encouraging trips by foot and bicycle helps to reduce demand for limited street and parking space capacity. Unlike driving, walking and bicycling as a means of transportation is more accessible to a broader range of individuals, particularly children and seniors who may otherwise not be able to drive. Given the broader range of ages of walkers and bike riders, safety in the design of these facilities is an important consideration.

Bicyclist on Dresden Road.

Improved Public Health. There is a vast and growing body of evidence that physical activity is important for both physical and mental health. In the United States, higher levels of walking and bicycling are correlated with lower obesity levels; lower diabetes rates; and lower incidence of high blood pressure.[1] Walking is one form of exercise readily available to most individuals; research increasingly notes that walking 30 minutes a day is an exercise regimen that holds many health benefits and is accessible across the spectrum of age, economic position and ability.

A Healthy Environment. Driving is a major contributor to air, water and land pollution and climate change. Walking and bicycling promote a more sustainable and healthy environment because they are both zero emission modes of transportation.

1 Alliance for Biking and Walking, *Bicycling and Walking in the United States, 2010, Benchmarking Report*. Washington, DC, 2010.

Enhanced Economy and Quality of Life. Numerous studies have found that communities that are pedestrian and bicycle friendly have economic advantages including higher property values, are attractive to 'creative economy' professionals and tourists, lower commuting costs and lower costs to taxpayers. Walking and bicycling also contributes to improved quality of life and a greater sense of community.

Pedestrian and Bicyclist Planning Goals

The Hanover Bike and Pedestrian Advisory Committee has adopted the following Vision Statement, Mission and Goals for Hanover:

Vision:

To develop an enlightened public policy and community support that encourages walking and cycling.

Mission:

The Hanover Bicycle and Pedestrian Committee is dedicated to educating and influencing public policy for the safe accommodation of cycling and walking for transportation, commuting, recreation, individual and environmental health. The Committee informs and advises the Town on matters of pedestrian and cyclist safety and road design consistent with the values and objectives expressed in the Town of Hanover Master Plan.

Hanover Pedestrian and Cyclist Goals:

1. Increase the level of walking and bicycling in Hanover:
    a. Infrastructure: Build infrastructure that encourages walking and bicycling, that ensures pedestrian and cyclist safety, convenience, and accessibility as well as enjoyable travel
    b. Connectivity: Create links for pedestrians and cyclists, on streets and other places, which connect neighborhoods, schools, shopping, places of employment, transit, and public spaces.
    c. Access: Prioritize routes to school and transit that enable pedestrians and cyclists to travel safely and freely.
    d. Streetscapes and Land Use: Create an environment using landscaping, public spaces and amenities that encourages pedestrian and cyclists travel; buildings a sense of community; complements neighborhoods and commercial districts; and reduces impacts on air and water resources.
    e. Mobility Alternatives: Adopt programs to increase the use of transit, ridesharing and other forms of mobility to help promote pedestrian and cyclist activity.
2. Integrate pedestrian and cyclist considerations into all projects, policies and the planning processes.
3. Inform and educate residents of the benefits of walking and cycling.
4. Develop a comprehensive pedestrian and cyclist plan based on the 'Five E's' as follows: Education, Engineering, Encouragement, Enforcement, and Evaluation.
5. Strive to achieve the standards of the League of American Bicyclists to be designated a Bicycle Friendly Community and the Pedestrian and Bi-

cycle Information Center to be a Walk Friendly Community.

As discussed above, higher levels of walking and bicycling conserves energy, contributes to cleaner air, reduces the need for parking and improves personal health and fitness. The plan recognizes that walking and bicycling serve both transportation and recreational needs. As a small town with mix of residential, employment, education, recreational and cultural attractions all within a compact area, walking and bicycling are, and have historically been, a viable means of transportation. This plan sets forth a long term vision of a pedestrian and bicycle network for Hanover that is safe and convenient for a broad cross- section of walking and bicycling abilities.

Factors that Influence Walking and Bicycling

Encouraging walking and bicycling is a fertile area of research related to transportation, congestion, environmental factors and health and wellness. Based on research to date a number of specific factors have been shown to affect demand for walking and bicycling (non-motorized transport) in a particular situation. These include (Victoria Transport Policy Institute)[2]:

- *Attractions.* Certain activity centers tend to be major attractors for walking and cycling, including commercial districts, school-college-university campuses, employment centers, recreation centers and parks.

- *Trip distance.* Most walking trips are less than a mile, and most bicycling trips less than 5 miles in length, although recreational trips are often much longer.

- *Demographics.* Young (10-20 years), elderly, and low-income people tend to rely more on walking for transport. Young and low-income people tend to rely on cycling for transport. Households with lower vehicle ownership rates tend to rely more on non-motorized modes than those with one vehicle per driver.

- *Land use patterns (density and mix).* Walking and bicycling for transportation tend to increase with density (i.e., number of residents and businesses in a given area) because higher density makes these modes more efficient.

- *Travel conditions.* Wide roads with heavy, high-speed vehicle traffic can form significant barriers to non-motorized travel. Special facilities for non-motorized travel (sidewalks, wide curb lanes, and paths), their condition and connectivity can have a significant impact on the amount of walking and bicycling that occurs.

- *Topography and climate.* These factors can affect walking and bicycling, but not as much as might be expected. For example, the cities of Seattle WA, Portland OR and Missoula MT report significantly higher levels of cycle transportation than many "Sunbelt" cities that are flat and have mild climates.

- *Community attitudes.* Local attitudes can have a major impact on the level of cycling in a community. For example, it may be unremarkable that cycling tends to be high among college students and staff, but many college towns find that cycling is also relatively common among people who have no formal affiliation with the college simply because it has become an acceptable form of transportation. This indicates that some people hesitate to cycle, but will if they perceive it to be more socially acceptable.

Pedestrians on South Street in the downtown.

- *Time and geographic scope.* It may take several years for a community to fully achieve its full non-motorized travel potential. First year impacts are frequently modest, but tend to increase as individuals become more accustomed to non-motorized travel and as additional support facilities (pedestrian and bicycle network, bicycle parking, etc.) develop.

These factors form the foundation of understanding that this plan is built upon.

2 Victoria Transport Policy Institute, Online TDM Encyclopedia, www.vtpi.org.

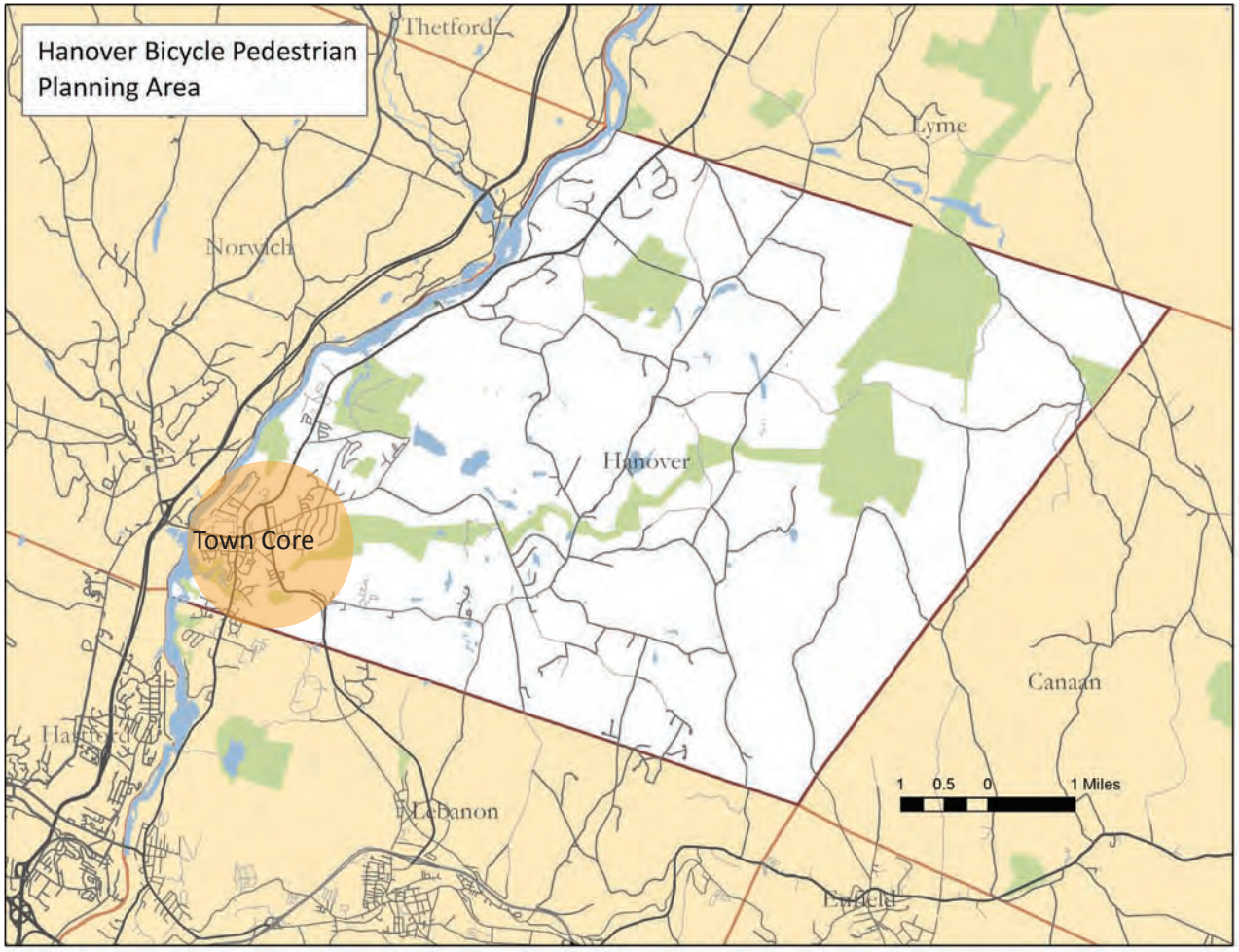


Figure 1. Plan Area

Plan Area

This plan addresses the limits of the Town of Hanover. The plan does look at routes connecting to DHMC and Sachem Village, although both are located in neighboring Lebanon. From a circulation perspective both areas are closely integrated with the College and Hanover.

Setting

The Town of Hanover had a 2000 population of 10,850. The Town is set along the Connecticut River which forms the western boundary of New Hampshire. Hanover is home to Dartmouth College, established in 1769, one of nine colleges established in the United States prior to the Revolutionary War. The college campus and town center are very closely intertwined. The density of people and activities within the compact core of the college and Hanover's downtown provides an environment well suited to walking and bicycling. Dartmouth College has an enrollment of over 6,000 undergraduate and graduate students and 4,000 employees. The College, as a major educational institution, employer and center of cultural offerings for the Upper Valley and beyond, has always had major influence on the Town's traffic patterns.

Walking and Bicycling in Hanover

Hanover enjoys very high levels of walking and bicycling: according to US Census *Journey to Work* data, the combined pedestrian and bicycle mode share in Hanover was 36.5% in 2000. By comparison, the statewide average at that time was 3.7%. Significant levels of walking and bicycling in college and university towns is not uncommon, however. For example, 9 of the 13 Platinum and Gold level 'Bike Friendly Communities' as identified by the League of American Bicyclists are college towns.[3]

Despite these high levels of walking and bicycling, Hanover's pedestrian and bike mode share declined between 1990 and 2000, when it accounted for 43.2% of work trips. The drop in the pedestrian and bicycling mode share between 1990 and 2000 is likely a reflection of the growth of both the town and the College, the move of Dartmouth-Hitchcock Medical Center from the Dartmouth College campus in Hanover to Lebanon in 1991, and employees living in more remote, rural locations. The US Census did not collect Journey to Work data in the 2010 Census; more recent data is not yet available.[4]

3 The communities are: Boulder, CO; Davis, CA; Portland, OR (Platinum); Corvallis, OR; Eugene, OR; Fort Collins, CO; Jackson and Teton, WY; Madison, WI; Palo Alto, CA; San Francisco, CA; Seattle, WA; Stanford University, CA; Tuscon and East Pima, AZ; (Gold).

4 Journey to Work data is collected annual from a sample of the population through the American Community Survey. Data for the 2005 - 2009 period for Hanover is not currently available.

Dartmouth College

Dartmouth College has long promoted alternative modes of transportation, including transit, ridesharing, walking and bicycling for its students, faculty and staff. As of fall 2010, there were 4,248 undergraduates and 1,893 graduate students for a total enrollment of 6,141 students. [5] Over 90% of college undergraduates live on campus; this percentage has increased significantly over the last 10 years with the college's construction and improvement of housing on campus. Freshmen are not allowed to bring a car to campus; there-after, students must park in A-lot (East Wheelock near Burton Road at a cost of $42 per quarter). College supported graduate student housing is in place on campus, at Sachem Village and within the Town of Hanover.

Faculty and staff account for 4,060 employees. According to data from the Dartmouth College, eight percent (8%) of College employees walked or bicycled to work in 2009. Looking at all College employees, 38% arrive via the Ledyard Bridge; 24% via Route 120/Lebanon Street; 12% via South Main Street; 11% Route 120/Lyme Road; and 10% via East Wheelock Street. [6]

For a complete list of Dartmouth College Green Commuter programs, see Appendix A. Specifically related to pedestrian and bicycle circulation includes the following programs:

- The campus supports an extensive pedestrian network including pedestrian crossings and blue light security phones.
- Bike racks are located throughout the campus; these are typically conveniently located near major buildings. The first weather protected bike rack was put in place at the new Life Sciences building -- it has been extremely popular. More sheltered racks and lockers are in planning phases.
- Bike and pedestrian commuters may sign up for free access to showers at Alumni Gym.

In addition, the Dartmouth College Office of Sustainability promotes bicycling on campus through a couple of programs:

- Refurbishing bikes left behind on campus and selling them at the 'Move In' sale at the beginning of the academic year.
- Pop-up bike shop, which provides assistance in bike repair for students.

Pedestrian and Bicyclist Counts

In general there is little data regarding pedestrian and bicyclist travel in Hanover, and collecting this data is a natural role for the Hanover Bike and Pedestrian Committee (discussed later). Understanding travel patterns helps make informed decisions regarding the pedestrian and bicycle infrastructure. The available data is summarized below:

Main and Wheelock Street. A recent traffic study conducted for the Hanover Inn collected pedestrian and bicycle volumes at the corner of Wheelock and Main Street. These counts, conducted between 7:00 am to 1:00 pm and 3:00 to 6:00 pm counted 2,745 pedestrian crossings of this intersection and 224 bicycle crossings of this intersection. No data was collected for the hours between 1:00 and 3:00 pm, which are often peak walking and bicycling

Top: Pedestrians crossing W. Wheelock at Main Street.
Bottom: Bike lane on Lyme Road.

5 Dartmouth College Department of Institutional Research, Dartmouth Facts and Figures, Fall 2010. http://www.dartmouth.edu/~oir/pdfs/studentlife_10.pdf

6 Joanna Whitcomb, Director of Campus Planning, personal communication, March 10, 2011.

Above, bus riders at the Ray School. Below, pedestrians negotiate the fence at the end of Dresden Road.

hours, so daily volumes are likely to be much higher.[7] Regardless, the point remains that the intersection of Main and Wheelock Streets is a key community crossroads where pedestrian and bicycle volumes are very high.

South Park and Valley Street. The Hanover Bike and Pedestrian Advisory Committee collected bicycle and pedestrian counts on South Park Street at Valley Road in order to document activity 'before' the installation of bike lanes and sidewalks at this location. Counts were collected on May 26, 2011. The counts collected data between 7:00 am and 6:00 pm. During this time period there were 337 pedestrian crossings at this location, between 20 to 30 per hour, with the peak activity between 5:00 to 6:00 pm, the noon hour and 8:00 to 9:00 am. During the same time period there were 164 bicyclists using South Park Street. About 20% of the bicyclists (34) rode on the sidewalk. Most of the sidewalk riding activity took place in the afternoon hours when traffic volumes on Park Street were higher and appeared to be bicyclists making short local trips as opposed to long commutes.

DHMC Survey. An survey of DHMC employees conducted at DHMC surveyed bicycle commuters in March 2009. The survey found that out of 87 respondents, 31 came from Hanover or Etna (36%) and over two-thirds of the riders (59) rode to DHMC from outlying communities via Hanover. [8]

7 Stephen G. Pernaw & Company, Inc, "Traffic Impact Assessment, Proposed Hanover Inn Expansion," December 2010. Counts were collected in November, 2010.

8 John Leigh, personal communication, April, 2009.

Hanover Schools

There are three public schools in Hanover. They are:

Bernice A. Ray Elementary School

Reservoir Road

Grades K through 5

Enrollment: 500 students

Frances C. Richmond Middle School

Lyme Road

Hanover Grades 6 through 8

Norwich Grades 7-8

Enrollment: 425 students

Hanover High School

Lebanon Street

Grades 9 through 12

Hanover, Norwich and Lyme

Enrollment: 749

In the Fall of 2008 a bus ridership study conducted for SAU 70 found that 54% of Ray School students and 57% of Richmond School Students ride the bus. In June 2009, both schools conducted Safe Routes to School parent and in-class surveys regarding travel to school. Preliminary analysis of the surveys revealed the following modal split by school:

Bike commuter on Lebanon Street.

Bernice A. Ray Elementary School

School Bus: 45%

Family Vehicle: 38%

Walk: 9%

Bike: 3%

Carpool: 4%

Transit: 0%

Other (scooter, etc.): 1%

Frances C. Richmond Middle School

School Bus: 57%

Family Vehicle: 31%

Walk: 6%

Bike: 2%

Carpool: 1%

Transit: 3%

Other (scooter, etc.): 0%

The Ray School PTO Transportation Committee conducted an online parent survey in 2008 regarding transportation to the school. Among the findings of this survey, 75% of parents who drove their students to school reported that they would prefer that their students walk, bike or ride the bus. Changes that were identified to help achieve their desire include:

- Reduced travel time on the bus (34.8%)
- Sidewalks along the route (25.5%)
- Bike lanes along the route (19.5%)

The SAU #70 District promotes awareness of walking and bicycling and sponsors 'walk and bike to school' days. The Town has received a grant to work with the school district to prepare a Safe Routes to School Travel Plan.

Travel data for Hanover High School by mode is not available; however it must be noted that the school's in-town location and limited number of parking spaces restricts student driving to school.

The Dresden School Board has set priorities for distribution of limited available student parking spots as follows: 1) Hardship Students (a situation out of the student's control that causes a need to drive in order to attend classes on a daily basis); 2) Tuition Students (a maximum of 15 spaces on Hovey Lane are available for tuition students); 3) Seniors may enter a lottery for remaining student parking spaces on campus. There is a fee for these student parking permits.

Hanover High School is accessible by foot and bicycle from in-town neighborhoods, and is served by the school bus system and Advance Transit.

Accident Data

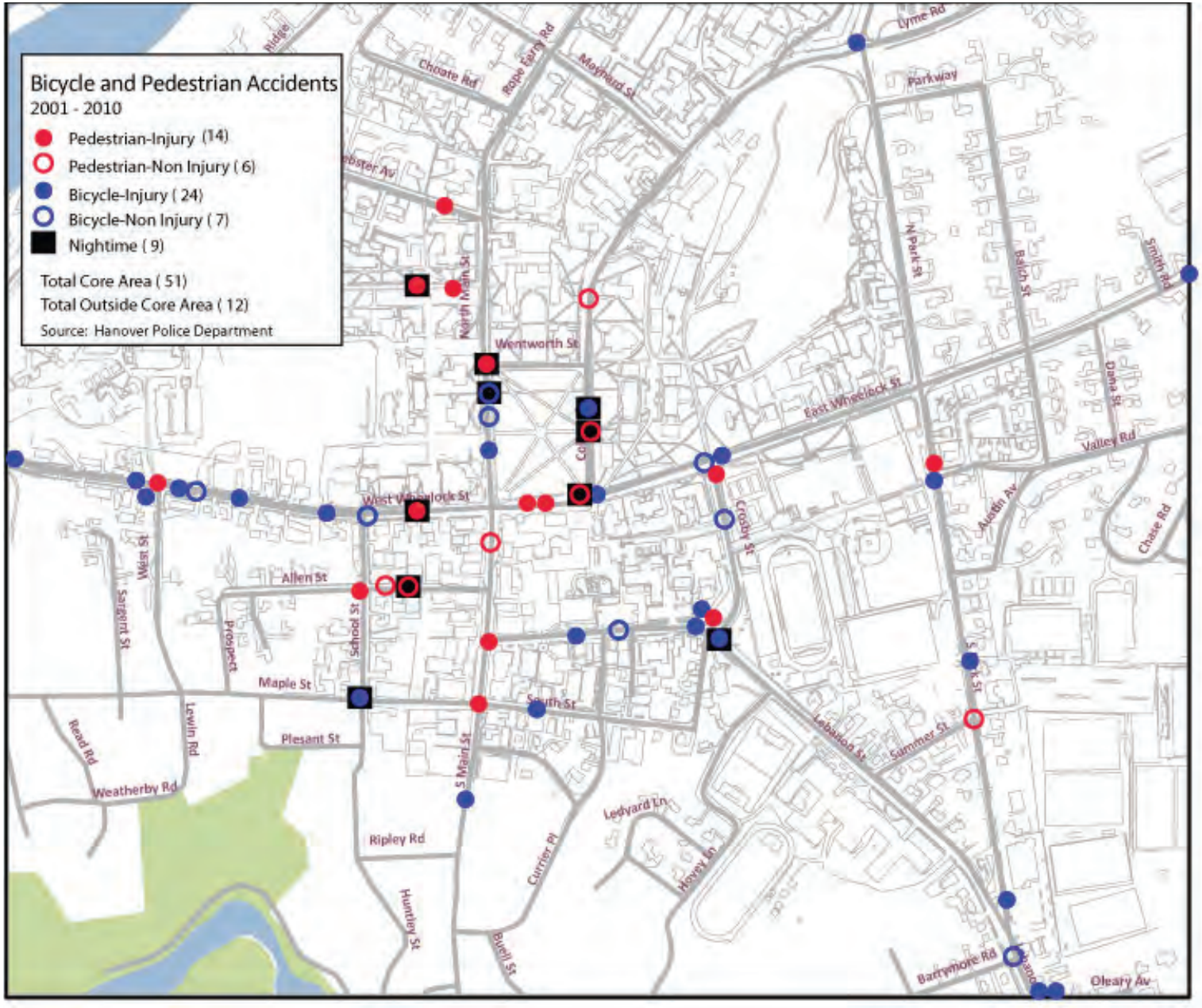
Bicycle and pedestrian accident data for the past 10 years is displayed in Figure 2. Overall, the number of accidents are relatively low given the high volumes of pedestrians, bicycles and traffic on core streets in Hanover. The following summarizes the main characteristics of the accident data:

Total number of reported accidents: 65

- Pedestrian collisions with motor vehicle: 25
- Bicycle collisions with motor vehicle: 40
- Accidents in the core (see map) 53
- Outside the core: 12

Time of Day

- Daytime: 55
- Nightime: 10



Number of Accidents by Street:

W. Wheelock Street:	11
Lebanon Street:	10
Crosby Street:	8
E. Wheelock Street:	8
Park Street:	9
College Street:	5
North Main Street:	4
South Main Street:	4
Allen Street:	3
School Street:	3
Great Hollow:	3
Lyme Road:	3
Reservoir Road:	2
Ruddsboro Road:	2
Hanover Center Road:	1
Rivercrest Drive:	1

Figure 2: Pedestrian and Bicycle Accidents 2001-2010

Factors Contributing to Accidents

Factors contributing to accidents are noted below. Note: not all accidents are included.

Pedestrians:

Inattention of driver:	10	
Crossing without looking:	5	(Primarily Main Street/College Street/Tuck Drive/Webster)
Hit in crosswalk:	5	(Primarily Wheelock Street/Crosby Street)
No crosswalk exists:	3	(W. Wheelock / School Street)
Dark/poor visibility:	4	(Campus areas around the Green and Tuck Drive)
Crossing from between parked cars:	2	(Campus area)

Bicyclists:

Inattention of Driver:	10	
Driveways:	8	(Primarily West Wheelock Street)
Sidewalk riding:	7	(Primarily Wheelock /Lebanon /S. Main/ College St./S. Park)
Wrong way riding:	2	(Lebanon/South Street)
Dooring:	1	(Lebanon Street)

Using this data as a starting point, supplemented with field observations, a couple of areas emerge as areas of concern: for pedestrians, crossing Wheelock Street and areas around the Dartmouth Green; for bicyclists, West Wheelock Street, streets around the Green, Lebanon Street/Route 120.

Pedestrians

"The sum of the whole is this: walk and be happy; walk and be healthy. The best way to lengthen out our days is to walk steadily and with a purpose."
-Charles Dickens

New Hampshire State Statues

'Pedestrians Rights and Duties' under New Hampshire state statutes are described in RSA 265:34-40. The question often is raised regarding the 'rules of the road' so these key provisions of New Hampshire statues are listed below for reference.

Pedestrians Subject to Traffic Signs and Regulations. – A pedestrian shall obey the instructions of any traffic sign or regulation specifically applicable to him, unless otherwise directed by a police officer. Pedestrians shall be subject to traffic and pedestrian control signals as provided in RSA 265:9 unless required by local ordinance to comply strictly with such signals. At all other places, pedestrians shall be accorded the privileges and shall be subject to the restrictions stated in this chapter. (NH RSA 265-34).

Pedestrian's Right of Way in Crosswalks .

- When traffic control signals are not in place or not in operation the driver of a vehicle shall yield the right of way, slowing down or stopping if need be to so yield, to a pedestrian crossing the roadway within a crosswalk when the pedestrian is upon the half of the roadway upon which the vehicle is traveling, or when the pedestrian is approaching so closely from the opposite half of the roadway as to be in danger.
- No pedestrian shall suddenly leave a curb or other place of safety and walk or run into the path of a vehicle which is so close as to constitute an immediate hazard.
- Paragraph I shall not apply under the conditions stated in RSA 265:36. crosswalk.

- Whenever any vehicle is stopped at a marked crosswalk or at any unmarked crosswalk at an intersection to permit a pedestrian to cross the roadway, the driver of any other vehicle approaching from the rear shall not overtake and pass such stopped vehicle. (NH RSA 265:35).

Crossing at Other Than Crosswalks

- Every pedestrian crossing a roadway at any point other than within a marked crosswalk or within an unmarked crosswalk at an intersection shall yield the right of way to all vehicles upon the roadway.

- Any pedestrian crossing a roadway at a point where a pedestrian tunnel or overhead pedestrian crossing has been provided shall yield the right of way to all vehicles upon the roadway.

- Between adjacent intersections at which traffic control signals are in operation pedestrians shall not cross at any place except in a marked crosswalk.

- No pedestrian shall cross a roadway intersection diagonally unless authorized by traffic control devices; and, when authorized to cross diagonally, pedestrians shall cross only in accordance with the official traffic control devices pertaining to such crossing movements (NH RSA 265:36).

Drivers to Exercise Due Care

- Notwithstanding the foregoing provisions of this chapter or the provisions of any local ordinance, every driver of a vehicle shall exercise due care to avoid colliding with any pedestrian or any person propelling a human-powered vehicle and shall give an audible signal when necessary and shall exercise proper precaution upon observing any child or any obviously confused, incapacitated or intoxicated person (NH RSA 265:37).

Pedestrians to Use Right Half of Sidewalk

- Pedestrians shall move, whenever practicable upon the right half of crosswalks (NH RSA 265:38).

Pedestrians on Roadway

- Where sidewalks are provided it shall be unlawful for any pedestrian to walk along and upon an adjacent roadway.

- Where a sidewalk is not available, any pedestrian walking along and upon a way shall walk only on a shoulder, as far as practicable from the edge of the roadway. Where neither a sidewalk nor a shoulder is available, any pedestrian walking along and upon a way shall walk as near as practicable to an outside edge of the roadway, and if on a two-way roadway, shall walk only on the left side of the roadway.

- Except as otherwise provided in this chapter, any pedestrian upon a roadway shall yield the right of way to all vehicles upon the roadway (RSA 265:39).

Hanover's Main Street is an attractive and friendly place to walk.

Characteristics of Pedestrian Friendly Streets

In many ways, Hanover is a walkers' haven: the small town setting, with a vibrant downtown ringed by attractive walkable neighborhoods; a college campus that is noteworthy for its connection into the town fabric; a network of small-scale streets (all two lanes); trails through river and wooded open space areas; a link of the Appalachian Trail. Initially established 250 years ago, the core of Hanover was designed for people to walk from place to place. The goal of this Pedestrian and Bicycle Master Plan is to preserve and enhance Hanover's townscape for pedestrians and to encourage walking as a viable means of transportation to get from point 'A' to point 'B' as well as for leisure and recreation.

As described in the introduction, there are a number of factors related to land use mix and urban design factors that significantly influence walking; detailed consideration of these factors are beyond the scope of this report. This report focuses on

A dense pedestrian walkway network serves the downtown and the core of the College campus.

factors related to the street right of way taking into consideration that we know people want to walk where there are many destinations and that the built environment is pleasant, human scaled and oriented to the street

The following summarizes essential design considerations for pedestrian utility, safety and comfort. Design considerations related to the public right of way must take into consideration that as a Town that is now 250 years old, many of Hanover's street rights of way are very constrained in terms of width and improvements must be considered on a case by case basis taking into consideration what is best for the pedestrian within available street rights of way.

Traffic Volume: Heavier traffic volumes and higher speeds on some streets diminish the environment for both bikes and pedestrians. Streets that carry the highest volumes in Hanover are as follows (2009 and 2010 data):

- Lebanon Street (so. of Summer Street): 16,000 ADT
- Lebanon Street / Route 120 (no. of Greensboro): 16,000 ADT
- West Wheelock St (NH 10A) at state line: 16,000 ADT
- South Park Street (NH 120) south of E. Wheelock: 10,000 ADT
- Lyme Road (NH 10) north of Ivy Point Way: 8,800 ADT
- South Main Street (NH 10) at town line: 7,200 ADT
- North Park Street: 7,000 ADT
- College Street (west of No. Park Street): 6,700 ADT

Pedestrian connections and alleys provide convenience and access. The landscaping, building entries and shop windows make these connections attractive and successful and give the downtown a unique sense of place.

Tree lawns provide a buffer for pedestrians, improving their comfort and safety.

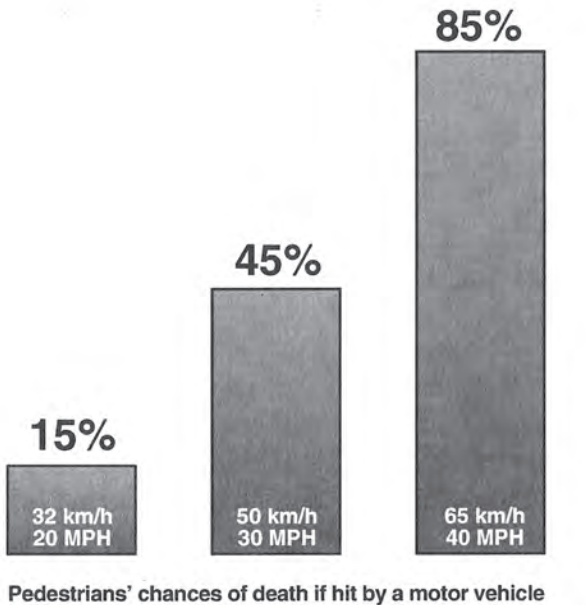


Figure 3. The relationship between speed and pedestrian fatalities. Source: Walk Tall: A Citizens Guide to Walkable Communities.

Example Block Sizes in Downtown Hanover

Dartmouth Green:	400' by 600'
No. Main St: W. Wheelock to Allen St:	300'
No. Main St. W. Wheelock to Lebanon St:	500'
W. Wheelock St: College to Crosby:	500'
W. Wheelock St: Crosby to Park Street:	900'

Where these higher volume routes traverse the town fabric, sidewalks should be buffered from the road with tree lawns to mitigate the effect of traffic volumes on bikes and pedestrians (bike accommodation is discussed below). In appropriate locations street parking and bike lanes also provide a spatial buffer between pedestrians and traffic. Fortunately, sidewalks with generous tree buffers are in place along many high volume streets, including West Wheelock Street, South Park Street, North Park Street, a portion of Lebanon Street, and College Street.

Traffic Speed: As shown in Figure 2, speed kills. A pedestrian's chance of surviving a collision with an automobile decreases drastically with the speed of traffic. At 20 mph, cars can stop relatively easily for a pedestrian and the risk of a pedestrian fatality from the collision is 5%; that risk increases significantly to 45% as speed increases to 30 mph; and the risk of a pedestrian death is 85% if the speed is 40 mph.

The greatest factor influencing traffic speed is road design – street and block patterns; lane widths; street widths; the presence of on-street parking; vertical and horizontal curves; corner radii. Posted speed limits will have limited effect on traffic speed if the road is designed for higher speeds.

Block Sizes: In most communities block sizes and the street network set the overall template for a walkable community. Block sizes influence walkability for a number of reasons:

1. Shorter blocks and more intersections create multiple route options and the possibility for pedestrians to use the most direct route between origins and destinations. While a distance of 50 or 100 feet is so small as to be immaterial in a car or even on a bicycle, such a distance is significant to a pedestrian, particularly when walking in cold or inclement weather.
2. Frequent intersections mean more places where cars must stop and pedestrians can cross the street. This supports finding a direct walking route, and also increases safety.
3. A dense network of streets disperses traffic so that streets carry lower traffic volumes and are more pleasant places to walk.

What block length is optimal? "For a high degree of walkability, block lengths of 300 feet, more or less, are desirable. Blocks of 400 feet to 500 are typical of older urban areas and are workable…" (Ewing). In the core of Hanover, where pedestrian volumes are very high, there are numerous pedestrian lanes and mid-block crossings that provide direct and convenient pedestrian routes. These lanes, intersections and crossings should be maintained and enhanced in the downtown and campus core to maintain a safe and effective pedestrian environment.

While the block size dimensions discussed above provide general guidance – considering context is crucial. The pedestrian network in downtown will be different than in lower density residential areas and common sense must be applied. It is clear that downtown Hanover and the core of the Dartmouth campus enjoy very high levels of pedestrian activity. Surrounding 'in-town' neighborhoods surrounding the downtown and the Dresden neighborhood also enjoy high levels of walking. Within these areas it is important to preserve and improve the rich and attractive network of streets, sidewalks, alleys, and pedestrian passages that provide a walkable network.

In downtown Hanover and the core of the college campus, the pedestrian network consisting of sidewalks, walkways and mid-block passages provides a robust walking environment with direct and efficient pedestrian routes between numerous commercial, institutional and residential destinations. The treatment of alleys connecting the main parking area behind Town Hall to Main Street add convenience for pedestrians and create a network that is excellent in terms of route directness.

The variety of the block patterns in Hanover adds to its pedestrian interest as well. A warped street grid like Hanover's, which provides an interconnected network of streets that calms traffic and provides visual interest for walkers, is preferred over long straight streets that encourage higher speeds.

Building Entries. In a pedestrian environment, building entries are oriented to the street and sidewalk. Building entries and walkways for public buildings and particularly on campus must be carefully considered to direct pedestrians to sidewalks and safe street crossings.

Sidewalks. Sidewalks are the most basic element of pedestrian infrastructure providing a means to separate pedestrians from cars and provide them with a comfortable route for walking. Sidewalks are also important social spaces where neighbors can meet, engage in conversation, and watch passersby in an outdoor setting. The importance of the social dimension of sidewalks has been studied by many prominent researchers, and sidewalks must be appreciated for their significant contribution to a community's quality of life and social appeal.[1]

1 See for example, Jacobs, Jane, *The Death and Life of Great American Cities*, Random House, New York, 1961; Appleyard, Donald, Livable Streets, University of California Press, 1981; Jacobs, Allan B., Great Streets, Massachusetts Institute of Technology Press, Cambridge, MA, 1993; Whyte, William, The Social Life of Small Urban Spaces, The Conservation Foundation, Washington, DC, 1980.

The basic design considerations for sidewalks are governed by the American with Disabilities Act (ADA) which sets basic requirements to eliminate barriers for persons with disabilities. Beyond basic ADA requirements, however, there are a number of considerations to make sidewalks as appealing and comfortable as possible to improve walkability.

Sidewalk Width: Typically, a minimum width of 5 feet is required. A five-foot wide sidewalk is adequate for two people to walk side by side and represents an adequate dimension for areas with light pedestrian traffic. For two couples to pass each other comfortably, twelve feet is necessary. ADA requires a minimum five-foot accessible route for circulation, and this area must be kept clear of benches, utility poles, trees, bike racks, etc. In the downtown and core of the campus, where pedestrian volumes are much higher, sidewalks should be wider, up to 15 - 20 feet depending on street furniture, sandwich boards, light poles, street furniture, buildings that run up to the sidewalk and require a 'shy distance' for pedestrian comfort.

The sidewalk width in the downtown retail district is tight given the volumes of pedestrians. Main Street and Lebanon Street is relatively narrow given the high volumes of pedestrians on those streets. Objects that can be obstacles to pedestrian movement, such as sandwich boards, which on the one hand enrich the pedestrian experience, must be carefully considered where sidewalks are narrow. Utility vaults should not be located in a sidewalk if possible. Any opportunity to provide a wider sidewalk, particularly on Lebanon Street between Main and Crosby, should be taken.

Public art along the street enhances the visual interest for pedestrians on Main Street.

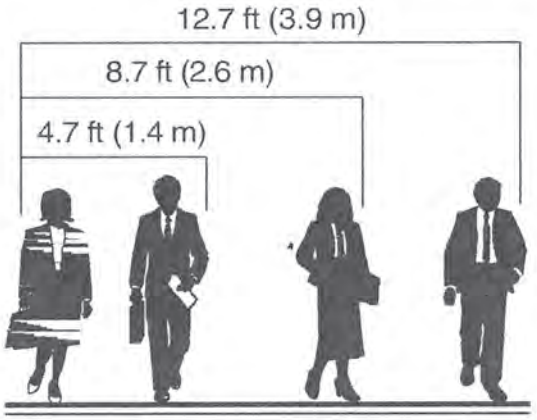


Figure 4. Spatial dimensions for pedestrians. (Improving Pedestrian Safety and Unsignalized Crossings, Transportation Research Board, 2006)

Above, 'green street' treatments in Portland, OR collects stormwater on curb extension which also provides a traffic calming benefit (above) Photo by Portland Environmental Services. 'Green street' treatment in Seattle utilized a curbless street (below).

Tree Lawn / Buffer: Where possible, it is highly desirable to include a tree lawn or buffer area between the curb edge and the sidewalk to improve the environment and visual amenity of the street. The green strip between the street and the sidewalk provides numerous benefits: buffering pedestrians from nearby traffic, providing shade and reducing the urban heat island effect, providing a vertical element that enhances the sense of enclosure and reduces perceived width of the street, absorbing and filtering stormwater runoff, and storing snow in the winter months. Hanover has a professional Urban Forester and an active tree planting program. In Hanover's very constrained rights of way, however, tree lawns are not always feasible. From a pedestrian point of view, streets that carry the highest volumes of traffic and pedestrians should be prioritized for street tree planting. In Hanover, these streets include Wheelock Street, Main Street, Park Street, Lebanon Street, Lyme Road, and College Street.

The width of the tree belt is an important consideration. For trees to thrive in this climate, a minimum width of five feet is required; while six or more feet will provide better growing environment for street trees. Buffer areas too narrow for tree planting can be planted with grasses, shrubs or ornamental plantings for visual interest. Due to their many visual and environmental benefits, tree planting should be the goal.

In areas where there is on-street parking, provision must be made for walking between the curb and the sidewalk. If a tree lawn is in place, paved walkways between the curb and the sidewalk (through the tree belt) are desirable. In very high volume pedestrian areas, such as downtown commercial streets, street trees planted in tree wells is the most appropriate treatment.

Street Trees: Street trees play an important role in creating a more pleasing walking (and bicycling) environment, acting as a buffer between pedestrians and motor vehicle traffic; creating a sense of enclosure and narrowing the perceived width of streets; providing shade in the summer; mitigating the urban heat island effect; and improving air quality. In general, street trees should be high crowned deciduous species that are tolerant of salt, pollution, soil compaction, and drought.

'Green Street' Planting: Tree lawn buffer areas also provide an opportunity to capture and manage surface stormwater from surrounding paved areas, thereby contributing to a more sustainable community. This approach to stormwater management can filter and remove excess sediments and other pollutants from runoff; reduce the velocity of runoff by detaining stormwater in an appropriately landscaped area; and allow retained stormwater to be absorbed into the ground and filtered through the landscape. Green street plantings can reduce the amount of polluted stormwater that enter into receiving creeks and waterways. This concept of a 'green street' can do double duty in creating a more attractive street for bike and pedestrians while also retaining stormwater and reducing water pollution.

The concept of green streets is a broad topic and there are numerous technical considerations and design approaches that need to be tested out in New England. This broad topic cannot be covered entirely in this plan but should be investigated in the future. There may be opportunities for demonstration projects that could identify which strategies are most successful. As stormwater pollution is growing environmental concern which is going through a cycle of innovation, special opportunities for funding 'green street' type projects may become available in the future.

The mid-block pedestrian crossing on Wheelock Street will include a pedestrian refuge and a curb extension for better visibility of pedestrians at this busy crossing.

White ladder style crossings are basic and visually effective markings for most crossings..

Crosswalks. Crosswalks greatly assist pedestrian navigation, comfort and safety. Crosswalks assist pedestrian safety by alerting motorists and bicyclists to look for pedestrians and by guiding pedestrians to a safe crossing. Pedestrians must be able to cross streets at regular intervals and cannot be expected to go 300 to 400 feet out of their way to take advantage of a formal crosswalk. [2]

There has been some debate regarding the placement of marked crosswalks at uncontrolled intersections (intersections without signals or stop signs), and these situations pose a dilemma for traffic engineers. An extensive study by the FHWA conducted in 2002, as well as more recent studies by the Transportation Research Board, help shed light on the best practices for pedestrian crossings at uncontrolled intersections.

As ever, decisions about marked crosswalks in Hanover must take into consideration the unique setting and situation of the town. First and foremost the core of Hanover, including the College, the downtown retail district and surrounding neighborhoods are ***major*** pedestrian generators. As shown in the modal split data discussed in the Introduction, as well as traffic studies conducted for various projects, Hanover enjoys very high levels of walking. As a small town, Hanover has a street network comprised of two-lane roads with ***many*** uncontrolled intersections and mid-block crossings. Guidance regarding the placement of marked crossings in Hanover must balance what we know about safety from research conducted and best practices from around the country with what makes sense for our unique town setting, bearing in mind that most studies have been conducted in areas with road conditions that are very different from Hanover.

2 Context Sensitive Solutions in Designing Major Urban thoroughfares for Walkable Communities, Institute of Transportation Engineers, 2010.

Table 1 on page 2-6 is an excerpt from the 2002 FHWA report and provides guidance regarding placement of marked crossings at uncontrolled intersections:

- when to consider a marked crossing; and
- where they should be provided with additional pedestrian facility enhancements such as traffic calming, pedestrian refuges, curb extensions, signals, signage, etc.

***Mid-Block Crossings*:** There are places along the street network where pedestrians will opt to cross mid-block rather than at the nearest controlled intersection. This may be due to a long distance between intersections, the desire to avoid back tracking, and/or high volumes of pedestrian-generating uses on opposing sides of the street. Formalized mid-block crossings improve pedestrian safety and convenience by managing the crossings and channeling them to a safe location. Mid-block crossings can help nearby intersections with capacity problems by allowing pedestrian crossings without taking capacity from the intersection.

Because mid-block crossings can be unexpected, they should be made highly visible to drivers. The crosswalk should be visually dramatic: a visible 'ladder' stripe pattern or fully painted out striping, integral colored, textured pavement set off by white bars. Signage should be used to warn drivers of an upcoming mid-block crossing. Mid-block crossings can be combined with speed tables or pedestrian refuges to add a measure of traffic calming to the crossing if warranted by street conditions. Traffic volumes and street use by emergency services are a consideration with respect to the use of speed tables.

Table 1. Recommendations for installing marked crosswalks and other needed pedestrian improvements at uncontrolled locations.*

Roadway Type (Number of Travel Lanes and Median Type)	Vehicle ADT ≤ 9,000			Vehicle ADT >9000 to 12,000			Vehicle ADT >12,000 - 15,000			Vehicle ADT > 15,000		
	Speed Limit**											
	≤ 30 mi/h	35 mi/h	40 mi/h	≤ 30 mi/h	35 mi/h	40 mi/h	≤ 30 mi/h	35 mi/h	40 mi/h	≤ 30 mi/h	35 mi/h	40 mi/h
2 Lanes	C	C	P	C	C	P	C	C	N	C	P	N
3 Lanes	C	C	P	C	P	P	P	P	N	P	N	N
Multi-Lane (4 or More Lanes) With Raised Median***	C	C	P	C	P	N	P	P	N	N	N	N
Multi-Lane (4 or More Lanes) Without Raised Median	C	P	N	P	P	N	N	N	N	N	N	N

* These guidelines include intersection and midblock locations with no traffic signals or stop signs on the approach to the crossing. They do not apply to school crossings. A two-way center turn lane is not considered a median. Crosswalks should not be installed at locations that could present an increased safety risk to pedestrians, such as where there is poor sight distance, complex or confusing designs, a substantial volume of heavy trucks, or other dangers, without first providing adequate design features and/or traffic control devices. Adding crosswalks alone **will not** make crossings safer, nor will they necessarily result in more vehicles stopping for pedestrians. Whether or not marked crosswalks are installed, it is important to consider other pedestrian facility enhancements (e.g., raised median, traffic signal, roadway narrowing, enhanced overhead lighting, traffic-calming measures, curb extensions), as needed, to improve the safety of the crossing. **These are general recommendations; good engineering judgment should be used in individual cases for deciding where to install crosswalks.**

** Where the speed limit exceeds 40 mi/h (64.4 km/h) marked crosswalks alone should not be used at unsignalized locations.

C = **Candidate sites for marked crosswalks**. Marked crosswalks must be installed carefully and selectively. Before installing new marked crosswalks, an engineering study is needed to determine whether the location is suitable for a marked crosswalk. For an engineering study, a site review may be sufficient at some locations, while a more in-depth study of pedestrian volume, vehicle speed, sight distance, vehicle mix, etc. may be needed at other sites. It is recommended that a minimum of 20 pedestrian crossings per peak hour (or 15 or more elderly and/or child pedestrians) exist at a location before placing a high priority on the installation of a marked crosswalk alone.

P = **Possible increase in pedestrian crash risk may occur if crosswalks are added without other pedestrian facility enhancements.** These locations should be closely monitored and enhanced with other pedestrian crossing improvements, if necessary, before adding a marked crosswalk.

N = **Marked crosswalks alone are insufficient, since pedestrian crash risk may be increased due to providing marked crosswalks alone. Consider using other treatments, such as traffic-calming treatments, traffic signals with pedestrian signals where warranted, or other substantial crossing improvement to improve crossing safety for pedestrians.**

*** The raised median or crossing island must be at least 4 ft (1.2 m) wide and 6 ft (1.8 m) long to adequately serve as a refuge area for pedestrians in accordance with MUTCD and American Association of State Highway and Transportation Officials (AASHTO) guidelines.

Source: Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations: Executive Summary and Recommended Guidelines, US Department of Transportation, Federal Highway Administration, February 2002.

Yellow highlighting indicates applicability in Hanover.

Colored textured pavement and a small speed bump slow traffic on College Street.

Speed table crossing on Maynard Street. This crossing could be augmented with white bars or painted 'yield' triangles for greater visibility.

Crosswalk Design Considerations: Once the crossing location is determined, the crosswalk should be located to be perpendicular to the street to the maximum extent feasible. This shortens the crossing distance and therefore the time a pedestrian is in the street, minimizing exposure to vehicles.

Hanover has three basic crosswalk designs: the ladder style crossing, and two approaches to enhanced crossings, textured, painted crosswalk with speed hump and a speed table crosswalk.

Ladder Style. This highly visible crosswalk striping is successfully used for the majority of crossings in Hanover. The visibility of the white stripes on asphalt is a simple and effective crosswalk treatment for the majority of crossings.

Enhanced Treatments for Crosswalks

In addition standard crosswalk markings and signage, certain locations merit additional treatments to assist pedestrians is crossing the street safely. These conditions include crossings at uncontrolled intersections, mid-block crossings, crossings on streets that have higher traffic volumes (i.e., greater than 9,000 ADT) or a location with a history of pedestrian/vehicle accidents.

Textured / Painted Crosswalk with Speed Hump. On College Street, crossings have been constructed with textured asphalt and painted to be visually prominent. The slight speed hump calms traffic along the street where there are very high volumes of pedestrians and parked cars along both sides of the street.

Speed Table Crosswalk. On Maynard Street, a wide crosswalk combined with a speed table has been constructed to accommodate pedestrians. The speed table has been treated with a thermoplastic stencil that is brick red with white edges.

High Visibility sign at Brockway and Lebanon Street.

Pedestrian activated Rapid Flash Beacon on Lebanon Street.

In every case, the white stop bar or ladder is the most visible part of the crosswalk. The visibility of the crosswalk on Maynard would be enhanced by traditional white painted 'yield lines' bordering the crosswalk.

I***High-Visibility Signs.*** High visibility warning signs, which are a bright flourescent yellow-green color and often include an arrow draw attention to pedestrian crossings and are beneficial for uncontrolled crossings where enhanced treatment is necessary, such as locations with higher volumes, higher speeds, or low motorist visibility.

Advanced Yield Stencils or Lines. Painted 'Ped Xing' stencils or yield lines (rows of triangles) in advance of marked uncontrolled crosswalks helps to warn motorists in advance of a crosswalk.

Flashing Beacons. Flashing amber beacon lights supplementing a pedestrian sign warn drivers in advance of pedestrian crossings. These beacons, flash continuously to catch a motorists attention for a general warning (rather than a warning directed at a specific crosswalk) where road conditions such as topography, speed, traffic volume merit an added measure of safety for pedestrians.

Rapid Flash Beacon. High visibility pedestrian crossing signs enhanced with rapid flashing lamps signal warning to drivers at a specific crossing. These signs are push button activated when a pedestrian wishes to cross the street and shut off after a specific time interval. The LED lights with solar panels reduce energy use and cost. This is an appropriate strategy for crossings on higher volume/higher speed streets.

Pedestrian countdown signal at Main and Wheelock Streets.

As described in the beginning of this report, Dartmouth College and Hanover's downtown are major pedestrian generators and mid-block crossings are in place at several locations in the pedestrian core.

Pedestrian Signals/Pedestrian Countdown Signals. At most signalized locations, Hanover has installed pedestrian demand signals, and on Main Street (where pedestrian traffic is very high) there is a separate pedestrian phase and countdown signal that allows pedestrians to cross in every direction and be aware of the amount of time remaining to cross the street. At other intersections, pedestrians are to cross during the green phase for that intersection approach, and turning vehicles should yield to pedestrians in the crosswalk. Pedestrian signals assist movement at busy downtown intersections where there are significant volumes of both pedestrians and cars. The pedestrian phase is also often used by bicyclists. Currently, the Greensboro Road / Lebanon Street intersection lacks accommodation for pedestrians (and bikes). This is discussed further in the recommendations section.

Pedestrian waiting periods at signals are a consideration as well. One handbook indicates that as a general rule, pedestrians are anxious to get back underway within 30 seconds. If waiting periods are longer, high school, college, and middle-aged adults, in particular, tend to look for a gap that they can use, or cross in other non-signalized locations.[3]

Median Pedestrian Island. This is a raised island in the center of a roadway separating opposing lanes of traffic that allows pedestrians to cross busy roadways one direction at a time. The center

3 Transportation Research Board, "Improving Pedestrian Safety at Unsignalized Crossings," TCRP Report 112/NCHRP Report 562, 2006. The referenced source is the Florida Pedestrian Planning and Design Handbook.

A number of enhancements are applied to this crossing: a pedestrian refuge island, high visibility sign, in-street crossing signs, advance yield lines.

In-Street Pedestrian Crossing sign on South Park Street.

refuge provides pedestrians with a better view of oncoming traffic and motorists with a better view of pedestrians. Median islands should be at least 6-feet wide (AASHTO) and should provide a clear and accessible path from curb to curb. This is an appropriate strategy for crossings on higher volume/higher speed streets.

In-Street Pedestrian Crossing Signs. In-street signs are placed in the center of the roadway or on a median to create a stronger visual appearance of the crosswalk and remind motorists of laws pertaining to pedestrian crossings.

Curb Extensions/Bulb Outs. Curb extensions narrow the distance that a pedestrian has to cross on a street, reduces their exposure to traffic and increases sidewalk space. They also improve the sight distance and visibility for both pedestrians and motorists. They are used in conjunction with on-street parking and prevent cars from encroaching into crosswalk zones.

For all their pedestrian benefits, curb extensions can be problematic for bicyclists if they are not properly designed and executed. AASHTO guidance suggest curb extensions that are 6-feet from the curb; this allows a 'shy' distance between the bulb-out and a bike lane as most parking lanes are 8 feet wide. Materials and design approaches that enhance the visibility of the bulb-outs at night is another important consideration. Bicyclists riding at night, when parked cars may not be present, may not be able to see a bulbout, and this presents a danger to the cyclist.

Finally, bulbouts present an opportunity to introduce planting and green space into the streetscape.

Driveway Curb Cuts: Vehicular curb cuts allow vehicles to cross a sidewalk into a driveway. As such they present the potential for conflicts between vehicles and sidewalk users as well as grade changes on the sidewalk which present tripping hazards a concern particularly in icy weather.

Curb cuts should be kept to an absolute minimum in number and width, particularly in the pedestrian core of town. The town's land use ordinances should reflect this goal by encouraging development to rely on alleys rather than curb cuts for access. Every attempt should be made to keep the pedestrian travel zone of the sidewalk free of grade changes; a maximum 2% grade per ADA for 3 feet should be viewed as a minimum standard. Finally, the sidewalk material (i.e., concrete) should continue across the curb cut so that vehicles are visually reminded that they are crossing a sidewalk.

Curb Return Radii: The curb radii at intersections affect pedestrians in two ways: 1) sharper turns (smaller radii) require cars to turn more slowly and 2) smaller radii create shorter crossing distances. Curb radii should be as small as possible in pedestrian intensive zones, taking into consideration the largest vehicle type that will frequently turn the corner (the 'design' vehicle), and the turning path requirements. As a guideline for pedestrian zones, curb return radii should be 15' (ideal) to 30' (where required by larger vehicles for turning paths).

In addition to street corners, this is perhaps a bigger issue for driveway curb cuts in the downtown and on campus.

Wide curb radii lengthen the crossing distance for pedestrians and discourage motorists from slowing down to turn the corner.

Benches and Sitting Walls: Street furniture, and benches in particular, provide an amenity that encourages walking. Benches should be placed along streets that have high pedestrian volumes and prioritized for locations such as the downtown, campus and Dresden neighborhoods, near major building entries, retail and restaurant destinations, sidewalks near senior housing and transit stops. For seniors, benches located along walkways between home and destinations such as the Coop or the library allow for taking a rest en route, and help to make the trip by foot more feasible.

Sitting walls are also attractive for social gathering places. The sitting walls in front of the Nugget Theater are very popular and successful amenities for public seating at an area with high public use.

AT bus stop on Main Street.

Trail along sewer easement to Camp Brook Common.

Transit Shelters / Waiting Areas: Transit stops add to the vitality and life of the pedestrian environment. Stops with high boardings are greatly enhanced by attractively designed waiting areas which may include a bench, shelter (ideally with route and schedule information), trees, good lighting, nearby crosswalk, and identifying signage. Pedestrian safety, comfort and accessibility are paramount concerns at transit stops.

Lighting: Hanover has attractive, pedestrian scale (i.e., 10' to 14' in height) light fixtures in place along its core streets which carry high volumes of pedestrians, and the College has pedestrian scale lighting along campus pedestrian promenades. The town has recently retrofitted the downtown light fixtures with high energy efficiency LED fixtures which, in addition to being more energy efficient, also have better lighting quality. The cobra head fixtures mounted on power poles, on the other hand, do not provide effective illumination of pedestrians.

Sewer Easements: Sewer easements have the potential to provide off-street paths that can be direct and efficient connections for walkers and bicyclists. An example of this is the path from Reservoir Road to Camp Brook Common, which is a well-used path to the Ray and Richmond Schools and between neighborhoods. Wherever possible, sewer easements should be planned and designated as public access easements for pedestrians and bicyclists as well.

Bicycles

"*I thought of that while riding my bicycle*."

-Albert Einstein regarding Theory of Relativity.

New Hampshire State Statutes and Town Laws

According the New Hampshire state law bicycles are vehicles and have the same rights to the roadway and duties as motor vehicles. (RSA 265:143). This means that 'bicyclists may occupy any part of a traffic lane when their safety warrants it. If the lane is too narrow to share, it is safer for the bicyclists to communicate that information by riding in the center of the lane.' (NHDOT *Don't be a Road Hog/Don't be a Road Warrior*)

New Hampshire recently joined several other states in passing a 'three-foot law' which requires motorists to allow a safe distance when passing bicycles:

Three- Foot Law. When passing a bicycle, leave a reasonable and prudent distance. That should be at least three feet when the vehicle is traveling at 30 miles per hour or less and one extra foot for every 10 miles per hour over 30. (RSA 265:143-a). Motorists may overtake bicycles only if it is safe to do so (RSA 265:18).

Other statutes that address frequently asked questions:

Where to Ride. Bicyclists must ride on the right side of the road , with the flow of traffic (RSA 265:16-II).

Riding Two-Abreast. Persons riding bicycles two or more abreast shall not impede the normal and reasonable movement of traffic and , on a laned roadway, shall ride within a single lane. (RSA 265:144-5).

Visibility. A bicyclist must wear at least one item of reflective apparel such as a reflective vest, jacket, or helmet from one-half hour after sunset to one-half hour before sunrise (RSA 265:144-12). When bicycling after dark a bicyclist must use a white front headlight and a red rear headlight or rear reflector visible for 300 feet. (RSA 266:86).

Helmets. Riders under the age of 16 must wear a helmet when operating a bicycle on a public way. (RSA 265:144-10).

Sidewalk Riding. Town of Hanover Ordinances prohibit persons over the age of 12 from riding on a sidewalk. (Hanover Ordinance #2 paragraph 15).

Top: Bicyclist on Lebanon Street (Route 120).
Bottom: Bike racks at the Co-Op.

Encouraging Bicycling as a Mode of Transportation

Many point to our cold, snowy winters and dismiss bicycling as a mode of transportation worth taking seriously. Interestingly, however, weather does not have a statistically significant influence on bicycling (Alliance for Bicycling and Walking, 2010.)[1] In the United States, Montana and Alaska are among the states with the coldest temperatures and are also among the states with the highest levels of bicycling. Minneapolis, Minnesota recently topped Portland, Oregon as the nation's most bike-friendly city (as designated by Bicycling magazine), and boasts the highest per capita number of bicyclists. Researchers point to investment in bicycling facilities (in particular separate cycling facilities), the availability of bike parking, integration of bicycles with public transit, traffic education and training for bicyclists and motorists, and promotional events as factors that have a clear influence on rates of bicycling (Pucher and Bueler).[2]

Recent studies point to the broader appeal of bicycling in countries with a developed network of separate facilities. In the United States male bicyclists outnumber women by a factor of 2:1. In The Netherlands women comprise 55% of cyclists. A recent study in New York City found that men are three times more likely to be cyclists as women; however a bicycle count on a path in Central Park found that 44% of the cyclists were women. Another study conducted in Portland, Oregon found that women riders would go out of their way to ride on traffic calmed 'Bike Boulevards.' (Baker) [3] In short, separate facilities that protect riders from traffic appeal to a broader population and hold the key to increasing bicycling as a mode of transportation.

A survey conducted in Portland, Oregon identified the following types of riders:

- '*Not interested*' approximately one-third of residents are not interested in riding a bike.
- '*Strong and fearless*' riders will ride anywhere with or without facilities and many times prefer no facilities at all. This group accounts for 1-2% of riders.
- '*Enthused and confident*' riders are comfortable with bike lanes on busy streets. They make up about 10% of riders.
- '*Interested but concerned*' riders make up about half the residents and are characterized as occasional riders that use bike trails and bike boulevards. These riders want to bicycle more but do not feel safe riding with traffic even when bike lanes exist. (City of Portland, Oregon, 2010).[4]

How is this relevant to Hanover? While the overall percentages of the population may vary somewhat, the rider profiles described exist in the general population and are useful in understanding different user groups. Research in the United States and abroad indicates that separate cycling facilities, specifically a network of bike lanes and bike paths, are associated with greater levels of bicycling because they tap into the 'enthused and confident' and 'interested and concerned' rider categories.

Within a two-mile radius of downtown (a very

1 Alliance for Biking and Walking, op.cit. page 127-128.
2 Pucher, John and Ralph Bueler, *Making Cycling Irresistible: 'Lessons from the Netherlands, Denmark, and Germany*,' Transport Reviews, July 2008.
3 Baker, Linda. 'How to Get More Bicyclists on the Road: To Boost Urban Bicycling, Find out What Women Want.' Scientific American, October 2009.
4 City of Portland, Oregon. Portland Bicycle Plan for 2030. February 2010. www.portlandonline.com/transportation

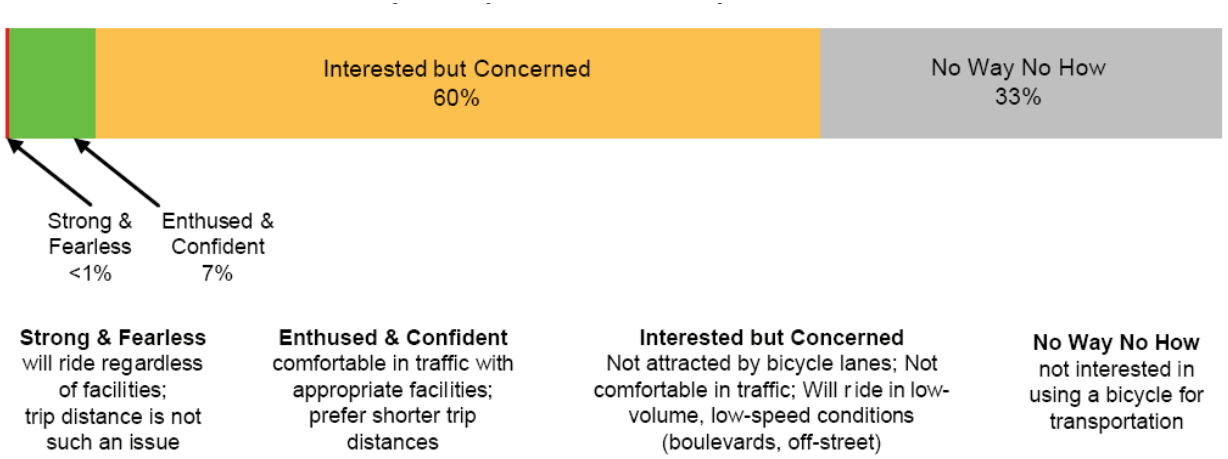


Figure 5: Four Types of Transportation Cyclists by Proportion of Population, Portland, Oregon. Source: Platinum Bicycle Master Plan, Existing Conditions Report.

Top: Shared Use Path next to a sidewalk; bike lane in street (Palo Alto, CA). Bottom: Cycle Track alongside a sidewalk (The Netherlands).

easy bicycling distance with grades that are flat to moderate) there are a number of significant destinations including Dartmouth College, DHMC, Sachem Village, the Ray and Richmond Schools, Hanover High School, two Coop grocery stores , downtown Hanover and numerous transit stops. In addition, 40% of all trips are less than 2 miles; 28% are less than one-mile. Using a bike for these short trips can be encouraged through a better bikeway network.

The approach to this master plan is to encourage greater levels of bicycling by expanding the bikeway network to address a range of riders, increasing bike parking and integrating consideration of cycling into planning for new development.

Types of Bicycle Facilities

Separate (Class I) Facilities

Shared Use Path. A Shared Use Path is an off-street path used by both pedestrians and bicyclists. A shared use path is typically a bi-directional facility. AASHTO guidelines recommend a minimum width of 10-feet for a shared use facility, and greater width, 12- or 14-feet , recommended where there is substantial use by bicycles, skaters, joggers and pedestrians (AASHTO, 1999)[5]. A shared use path may be located within park and open space areas or within developed neighborhoods and communities. Off-street paths are particularly attractive for the 'concerned' riders (more-risk averse riders and children) and recreational users because they provide separation from motor-vehicle traffic. They are less than ideal for the 'confident and fearless' bicyclists when there is higher levels of foot traffic or slower riders that impede use. Bicyclists' Level of Service

5 AASHTO (American Association of State Highway Transportation Officials), *Guide for the Development of Bicycle Facilities*, 1999.

Top: Bike lane on Lyme Road.
Bottom: Contra-Flow bike lane (Seattle).

(LOS) on pathways is significantly impacted when the amount of foot traffic surpasses 15 percent of trail use.[6]

Shared use paths (as well as Cycle Tracks discussed below) are best located in areas where there are minimal driveways and intersections. Driveways and intersections require special design consideration and signage to effectively warn motorists of bike crossings.

Cycle Track. A cycle track is a bike facility that is separate from both motor vehicle traffic and pedestrian traffic. A cycle track may be located in the street and buffered from adjacent traffic or may be raised like a sidewalk. A cycle track may be a one-way or two-way facility depending on the traffic and street context. Cycle tracks are typically applied in areas where there are few driveway and intersection conflicts and where traffic speed and volumes make it desirable to provide for separation between bikes and motor vehicle traffic. Street level cycle tracks are separated from traffic lanes by a parking lane (e.g., the cycle track is between the sidewalk and the parking lane) or a painted buffer space. Cycle tracks are attractive for a broad range of cycling abilities.

As a relatively new facility, design standards for cycle tracks are evolving and vary depending on street conditions. In general:

One way cycle track:	Street level - Minimum width of 5 to 7 feet, plus a minimum buffer to the street of 1-foot; 3-feet to a parking lane.
	Raised - Minimum width of 6.5 feet; plus a minimum buffer zone to the street of 1.5 feet.
Two-way cycle track:	Desirable width of 12-feet; minimum width in a constrained location is 8 feet.

Bike Lanes (Class II Facilities)

Bike Lane. A bike lane is a portion of a street set aside for exclusive or preferential use by bicyclists in urban areas. Bike lanes are one-way facilities that typically carry bicycles in the same direction as traffic (Exception: Contra-flow bike lanes (see below)). Bike lanes improve the comfort and confidence of riders. Striped and signed bicycle lanes make drivers aware that bicycles are to be expected along the roadway. While bikes are entitled to use travel lanes like motor vehicles, signed and striped bike lanes are a visual reminder to motorists that bikes are likely to be present. On streets where traffic volumes and/or speeds are low, such as many residential streets, or where there are no connections to the larger bicycle network, a designated bike lane is not needed. Bike lane recommendations (AASHTO and NACTO):

Traffic Volumes:	3,000 + ADT
Traffic Speed:	25 mph or higher
Width:	The minimum bike lane width adjacent to a curbface is 5 feet; the desirable bike lane width is 6 feet. The desirable ridable surface adjacent to a street edge without a curb may be less than 5-feet in width, but not less than 4-feet. Bike lanes less than 4-feet are not acceptable.

6 US Department of Transportation , Federal Highway Administration, Shared-Use Path Level of Service Calculator, a User's Guide, July, 2006.

Next to parallel parking spaces, bike lanes should be a minimum of 5-feet in width, with a 7- or 8- foot parking lane for a total of 12- to 13-feet.

Buffered Bike Lane. A buffered bike lane provides additional space between the bike lane and a vehicle travel lane or a parking lane. The purpose of the buffer is to provide greater space where traffic volumes and speed are higher or there is a higher volume of truck traffic.

Width: The buffer and the bike lane combined are considered the bike lane width. As a practical matter, the buffer must be a minimum of 2-feet, for a total minimum of 7 feet.

Contra Flow Bike Lane. As the name suggests, a contra flow bike lane allow bicycles to ride against the flow of traffic on a one-way street. These are used to provide a shorter, more efficient path for bicyclists to important destinations and often is applied where bicycles are already riding the wrong way.

Width: Same as for Bike Lane

Striping: A solid double yellow line separating the bike lane from traffic is recommended.

Class III Shared Routes

Bicycle Boulevard. A bicycle boulevard is a street that has been designed to facilitate convenient through movement of bicycles with traffic calming and restricted vehicle movements that will reduce motor vehicle speeds and volumes on these streets. Diverters that allow bicycles to pass but divert motor vehicles, traffic circles that slow traffic, stop signs that give preference to the bicycle boulevard are all ways that a street is made to place a priority on safe and seamless bicycle movement. Bicycle Boulevards are particularly effective for children and 'concerned' riders. One study in Portland, Oregon found that more risk averse riders, women in particular, will go out of their way to ride on that City's traffic calmed Bicycle Boulevards. Signage and pavement markings oriented to the bicyclist are other features that identify a street as a bicycle priority environment. Bicycle Boulevards are typically residential or local streets near major collector and arterial streets that provide connections to major locations and tie into the larger bicycle network.

The design elements of a Bicycle Boulevard depend on the unique setting of the street within a community.

Advisory Bike Lanes. Advisory bike lanes are an innovative technique that creates shared space on streets with no room for traditional bike lanes. Advisory bike lanes are used extensively in Europe on lower volume roads, and are under study in the United States. An Advisory Bike Lane consists of dashed lanes on the sides of the roadway that designate bike lanes, removal of the center stripe and its conversion to a single center lane enough for a single car at a time. The dashed lines allow cars to enter the lane if a bicyclist is not present and a car is approaching from the opposite direction, but formalizes space for bicycles. Advisory bike lanes can be combined with traffic calming to reduce traffic speeds to create a slow street. This striping essentially formalizes how cars and bike operate on narrow roadways anyway, but lends more support to the bicyclist.

This technique is currently experimental in the United States, but holds promise for small town and rural settings. In Hanover, Valley Road and Rip Road are possible candidates for this approach.

Top: Traffic calmed Bike Boulevard (Berkeley).
Bottom: Advisory bike lanes (The Netherlands).

Top: Bike lanes with parking (Norwich, VT).
Bottom: Through bike lane on Route 120 at Greensboro Rd.

Sharrows. Shared Lane Markings or 'Sharrows' are road markings that indicate the path for a bicycle where there is inadequate room for a bike lane. Originally devised to guide bicyclists out to the 'door zone' of parked cars, the use of Sharrows has expanded greatly to designate positioning for bicyclists and a path through complex intersections, shared roadways, to designate bicycle boulevards, or bicyclist wayfinding. 'Sharrows should not be used as a substitute for bike lanes or cycle tracks, where these types of facilities are otherwise warranted or space permits' (NACTO, 2011). Sharrows are approved for use by the MUTCD.

As a practical matter, Sharrows should be limited to the following conditions:

- Next to parallel parked cars on bicycle network streets
- Along gaps on streets with bike lanes
- On lanes where bikes are encourage to take the lane for safety
- Through complex intersections

Intersections

Bike Boxes. Bike Boxes are designated 'boxes' at the head of a traffic lane (behind a crosswalk) at a signalized intersection that allow bicycles to get ahead of traffic queues during a red light phase. A bike box facilitates left turn movements for bicyclists and help prevent 'right hook' conflicts with motor vehicles at the beginning of a green light at intersections where there is a heavy right turn movement. A bike box must include a restriction on turning right on a red light unless there is a exclusive right turn lane.

Dimensions: Bike boxes are typically 10- to 16-feet deep. Bike boxes are used both with and without bike lanes.

Striping: Striping includes visible white lines to demarcate the bike box. Bike boxes can be painted green for greater visibility or just designated with a bike symbol. Additional signage per MUTCD standard is desirable.

Through Bike Lanes. As streets with bike lanes approach intersections with turning lanes, through lanes assist bicyclists navigate by positioning them left of right turn lanes or right of left turn lanes.

Width: Through bike lanes should be a minimum of 4 feet in width and ideally 5- to 6 feet wide. A dashed merge lane designated by dashed white lines should begin a minimum of 50-feet before the intersection and 100-feet if along a high speed/high volume roadway (NACTO).

Combined Bike Lane/Turn Lane. A combined bike lane / turn lane provides a dashed bike lane over a turn lane to clarify the shared use of the space by motorists and bicyclists. This is used in constrained right of way situations where there is not adequate space for a through bike lane.

Width: Within the shared lane, a four-foot minimum width should be designated as the bicycle area.

Roundabouts. The modern roundabout is a circular intersection slows traffic at an intersection and by allowing traffic to remain slow and steady, often increases motor vehicle capacity. Numerous studies have shown that single-lane roundabouts have the potential to increase both motor vehicle capacity and motor vehicle and pedestrian safety. The conversion of an unsignalized intersection to a

single-lane roundabout is frequently indicated as a pedestrian safety countermeasure.

One of the most important features of roundabouts that improves safety for all users is that their approaches are narrow and deflected, requiring all vehicles to reduce their speeds as they pass through. With the narrow approach widths, bike lanes cannot be carried through a roundabout, so bicyclists generally have two options for navigating a roundabout.

1. Join with the vehicular traffic and ride through the roundabout as a motor vehicle. Due to the very slow traffic speeds, experienced riders are generally comfortable with this option.

2. For less confident or young riders, most roundabouts are designed to allow a bicyclists approaching to join into the sidewalk, and basically navigate the roundabout as a pedestrian. IN this case, pedestrians should dismount and walk their bikes over the crosswalks.

Research suggests multilane roundabouts may not have the same safety benefits, and may actually increase bicyclist collisions. Chapter 5 of the US DOT FHWA publication, '*Roundabouts: an Informational Guide*,' states that adding an additional lane to a one-lane roundabout is likely to increase overall injury crashes by 25 percent. (CalTrans, 2010).[7] Intersection designs, particularly along bike corridors, should take into consideration bicycle and pedestrian safety and needs as well as traffic flow considerations. If it is determined that other intersection options are significantly less effective, design treatments that address the needs of pedestrians and bicyclists (i.e., lower speeds, signage and pavement markings that assist navigation by bikes and pedestrian) at multi-lane roundabouts should be implemented.

7 CalTrans (California Department of Transportation), 'Complete Intersections: A Guide to Reconstructing Intersections and Interchanges for Bicyclists and Pedestrians,' 2010.

Other Treatments

Reverse Angle or Back-in/Head-out Diagonal Parking. As the name implies, reverse angle parking is angled parking designed for cars to back into the stall; when leaving the stall, the driver has a better view of the oncoming traffic, bicyclists and pedestrians. Reverse angle parking has the following advantages:

- ***Bicycle Safety***: This type of parking provides a safer environment for bicyclists using the roadways as the driver is able to see the cyclists when exiting the stall. In addition to better visibility while exiting the stall, rear-mounted bike racks and equipment is also oriented away from bicyclists in the travel lane. Several cities which have implemented back-in angle parking have seen a reduction in the number of accidents over conventional parking arrangements.

- ***Loading at the Street***. Back-in parking also places the trunk of a car at the sidewalk allowing people to stand on the sidewalk to load or unload their car. A corollary of this benefit is that rear mounted equipment, such as bike racks, are oriented away from bicyclists traveling in the roadway.

- ***Doors Open to the Sidewalk***. With cars oriented to the street, car doors block pedestrian access to the street and guide pedestrians to the sidewalk, another safety benefit, particularly for children (Nelson Nygaard Consulting Associates).[8,9]

8 Nelson/Nygaard Consulting Associates, "Back-in/Head-out Angle Parking, January 2005.

9 www.bicyclinginfo.org/bikesafe/case_studies, Back-in Diagonal Parking with Bike Lanes

Reverse angle parking in commercial district (Seattle).

One constraint with reverse angle parking is additional sidewalk width is needed for car overhang.

Although the use of reverse-angle parking has increased steadily in recent years, several cities have used this parking arrangement for decades including Wilmington, Delaware, which has had reverse angle parking for 50 years, and Seattle Washington, which has had reverse angle parking for more than 30 years (Nelson Nygaard, 2005).

Bicycle Detection at Signals. Detection of bicyclists at signalized intersections is necessary in order to decrease delay to bicyclists, and discourage red light running by cyclists without causing inordinate delays to motorists. Bicycle detection at intersections can be accomplished using several technologies; the most widely used are loop detectors and video detectors. In Hanover, video detectors are the preferred technology.

Intersections along bike routes with car detection only (such as Greensboro Road, Lyme/Park Street) should include dedicated bicycle detection.

Plan Recommendations

"Nothing compares with the simple pleasure of a bike ride."
-John F. Kennedy

The Pedestrian and Bicycle Network

The following recommendations are made to identify improvements to the pedestrian and bicycle network that will enhance connectivity from Hanover neighborhoods to significant destinations and encourage walking and bicycling. Some recommendations address the needs of pedestrians exclusively (sidewalks and crosswalks; some address bicyclists (bike lanes) and many address both (paths).

Figure 6 shows the recommendations for pedestrian improvements to the core area of Hanover. It should be noted that in addition to the streets in the core area, the campus and the downtown include a number of pedestrian walkways and lanes that are important components of the pedestrian network that should be maintained and enhanced as well. The missing sidewalk links, described below, are primarily along street rights of way and should be constructed in conjunction with adjoining development, programmed through the Capital Improvement Plan, or as opportunities arise.

While Hanover's network of sidewalks, pedestrian lanes and trails has been developing for the past 250 years, the bicycle network is in its relative infancy by comparison. The goal of the master plan is to identify a coherent and connected bikeway system that provides access to major destinations. The overall network is shown in Figure 8 and detailed in Figures 9 and 10. On the Master Plan diagram (Figure 8) the Primary Bicycle Routes are routes that should be developed to the highest possible level (e.g. a separate route and/or bike lanes) to encourage bicycling for a range of riders (commuters, school children, casual riders) in order to encourage trips for a number of purposes including work, school, shopping, recreation, and medical appointments. The planned bike network ties into a broader system being developed in neighboring communities, where possible, to support the development of a seamless bicycle transportation network in the Upper Valley.

Hanover's small town setting, limited street network, and constrained street rights of way provides a challenging setting for bicycle planning. The plan strives to be practical and implementable, while providing a coherent network that includes long range plans as well as short-term improvements. It is expected that the network will be developed over time as opportunities become available. Implementation of bike system improvements is expected to be made through a combination of implementation partners, primarily including the Town, property owners, and New Hampshire DOT.

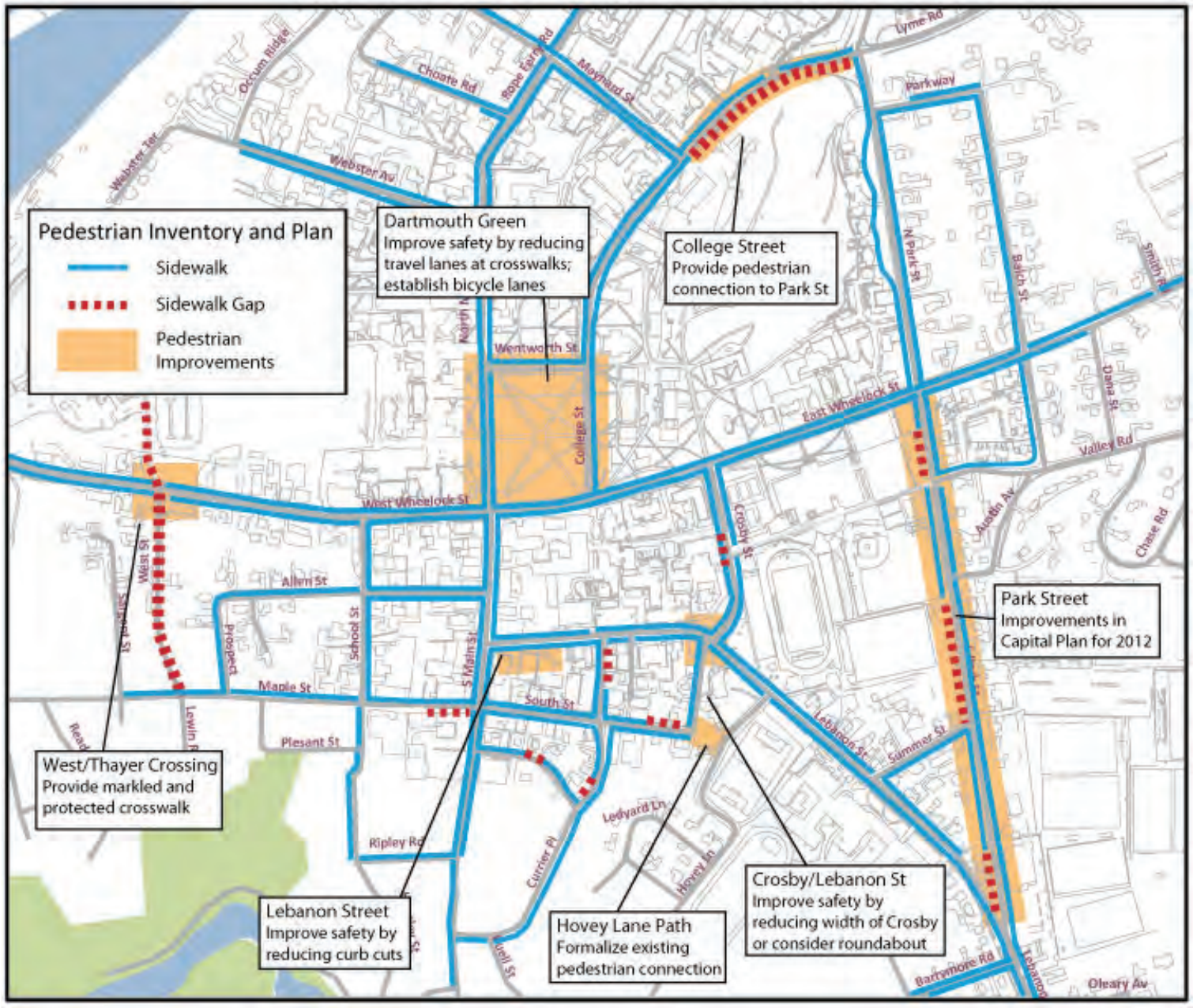


Figure 6: Recommended Pedestrian Improvements in the Downtown / Central Campus area

Top: Children waiting for the bus on Verona Road.
Bottom: Discontinuous sidewalk on Maynard Street.

Downtown - Central Campus Area

Missing Sidewalks and Paths

West Street/Thayer Drive. West Street provides an important pedestrian connection between the 'west end' neighborhood and the Dartmouth campus via Thayer Drive, as well as to an Advance Transit stop. A sidewalk along West Street should be considered. Thayer Drive, which is a major pedestrian entrance to the campus from surrounding student housing also lacks a sidewalk. Currently there is a painted out zone intended for pedestrians and a staircase. Although the grade is challenging, given the amount of activity at this area, pedestrian improvements should be a priority.

College Street. There is a well-worn path indicating a strong desire-line along the south side of College Street to the graduate student housing on North Park Street. Due to grades, this is a challenging location for an ADA accessible walkway, which would likely require a retaining wall and railings, but it is clearly an important link in the pedestrian network.

South Street to Hovey Lane Path. This path is a very heavily used pedestrian and bike path that provides a key link between Hanover High School and the Howe Library/ downtown and associated neighborhoods. This path is on private property and mulched by the Town. Given this is a pivotal link in the Town network, the Town should work with St. Denis' church to obtain a public access easement for this path, and pave it and maintain it for winter travel.

Connections to the path for bikes and pedestrians are recommended as well. Extension of the sidewalk from the Howe Library to the path is recommended as well as a new sidewalk along the west side of Hovey Lane to Lebanon Street. Accommodation for bikes to connect to the path from South Street are needed as well (contra flow bike lane or path) as Sandborne and South Street are one-way in this location.

Verona Road. This area is a focus of higher density housing, including Brook Hollow, The Courtyard, and Willow Spring senior apartments, a population including both children and seniors with high pedestrian activity, vertical and horizontal street curves with poor sight distance at one location. This is also a busy family neighborhood with a school bus stop and a nearby nursery school. A sidewalk should be constructed along both sides of Verona Road from Wheelock Street to the to the intersection of Willow Spring and Butternut Lane on the east side of the street, and from Willow Spring to Wheelock Street on the west side of Verona Road.

Crossings

Wheelock / West Street / Thayer Drive. Wheelock is a major entry into town from the west. Thayer Drive is an important portal to the campus, and leads to both the Thayer Engineering School and the Tuck Business School. The immediate area around the intersection on Wheelock Street is dominated by student housing, leading to a natural desire for pedestrians to cross Wheelock Street at this location. Due to the steep grade of Wheelock Street, cars and bikes traveling downhill are often traveling fast. There is also a transit stop at this location. There is no marked crosswalk at this difficult location, yet the observed pedestrian crossings are fairly heavy.

Using the FHWA guidelines (see Table 1) a marked crosswalk alone at this location would be insufficient and may increase the risk of a pedestrian

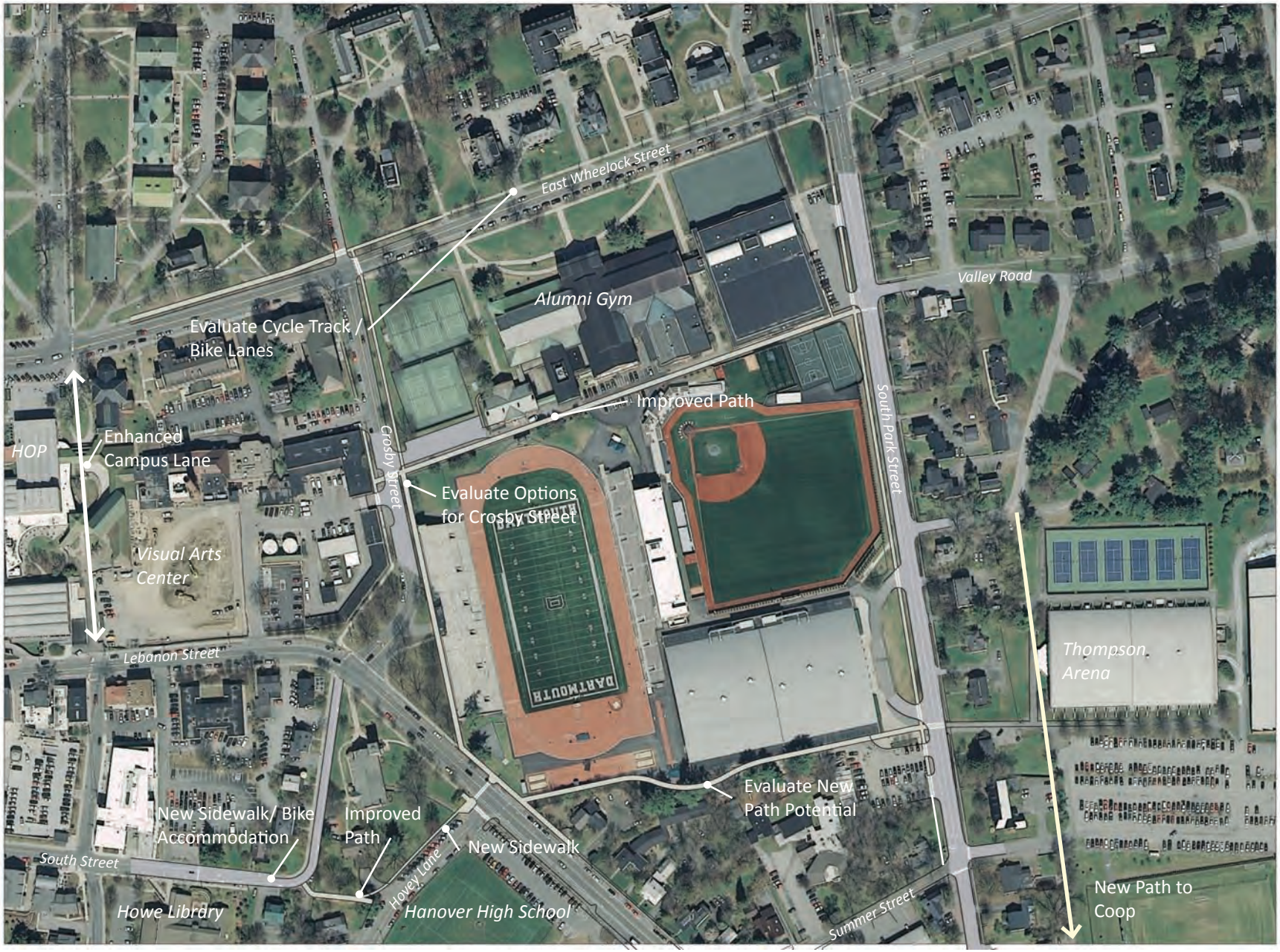


Figure 7: Conceptual Plan Central Hanover/ Central Campus Enhanced Pedestrian and Bicycle Network

Top: The path from South Street to Hovey Lane is an important connection in downtown Hanover.

crash. Other treatments such as traffic calming, pedestrian signals or a pedestrian refuge should supplement the crossing in order to improve safety for pedestrians.

In this area, a pedestrian activated rapid flash beacon sign in addition to a marked crossing would greatly assist pedestrian crossings in this location. Observations of pedestrian crossings should be taken to identify 'desire lines' for crossing. The location of the crosswalk and improvements should be coordinated with the College's plans for improving Thayer Drive.

College/Wentworth/North Main Street at Dartmouth Green. The streets around the green are overly wide for the traffic volumes and given the very high volumes and bicycle and pedestrian activity, consideration should be given to narrowing these roadways and tightening up the corner radii to shorten pedestrian distances and slow traffic turning the corners to the extent possible taking into consideration that buses and larger vehicles must turn at this location (Wentworth to North Main is a particular consideration in this regard). Consideration should be given to narrowing these streets, putting in bike lanes or cycle tracks, tightening up corner radii. There are a number of options that could be accommodated on these streets.

Lebanon Street/Parking Garage/Spaulding. There is a strong pedestrian desire line from the Hanover parking facility across Lebanon Street to the Hopkins Center. Pedestrian activity in this area should be observed to determine that the pedestrian network works well in this area.

Primary Bike Corridors

Dartmouth Green. College, Wentworth and North Main Street are wider than necessary for motor vehicle traffic. North Main and College Street have more frequent bike and pedestrian collisions. This is partially due to the sheer volume of pedestrians, bicycles and cars. In the short term, there is room for bike lanes in the direction of traffic. College and Wentworth Street are very wide one-way streets that can be narrowed considerably; College Street

Top and bottom: Different approaches to negotiating the intersection of Park and Lebanon Street.

Left: College Street. Right: Shared use path along College Street.

Above: Bicyclist at College above Park and Dewey Field Road.

and North Main Street, with their numerous pedestrian crossings would be safer with a narrower street width, as often a car waiting for a pedestrian to cross blocks the view of the pedestrian for an oncoming car in the other lane. Based on observations of bicycle traffic at the intersection of Main and Wheelock and discussion with Dartmouth users, two-way circulation for bikes around the Green is desirable. The possibility for a contra flow bike lanes or a cycle tracks around the Green should be evaluated. At a minimum North Main Street contraflow on North Main Street appears to be warranted. North Main Street represents a center of gravity for the campus and there is a strong desire line to enter the campus at North Main Street from South Main, and both directions on Wheelock Street.

College Street from Park to Maynard. This key connection into the College campus is a very constrained two-lane right of way. The narrow right of way of the street with on-street parking lanes does a good job of slowing through traffic entering from the north, but is unpleasant for bicyclists. The slight uphill grade after a signalized intersection (southbound) often results in slow moving cyclists with cars passing them in a narrow street right of way. In this area an off-street option in the form of a continuation of the Lyme Road shared use path alongside College Street and swinging west into the campus and connecting to Maynard Street would provide a better, more pleasant route for non-motorized transportation. At Maynard Street this path connects into streets that are relatively quiet and

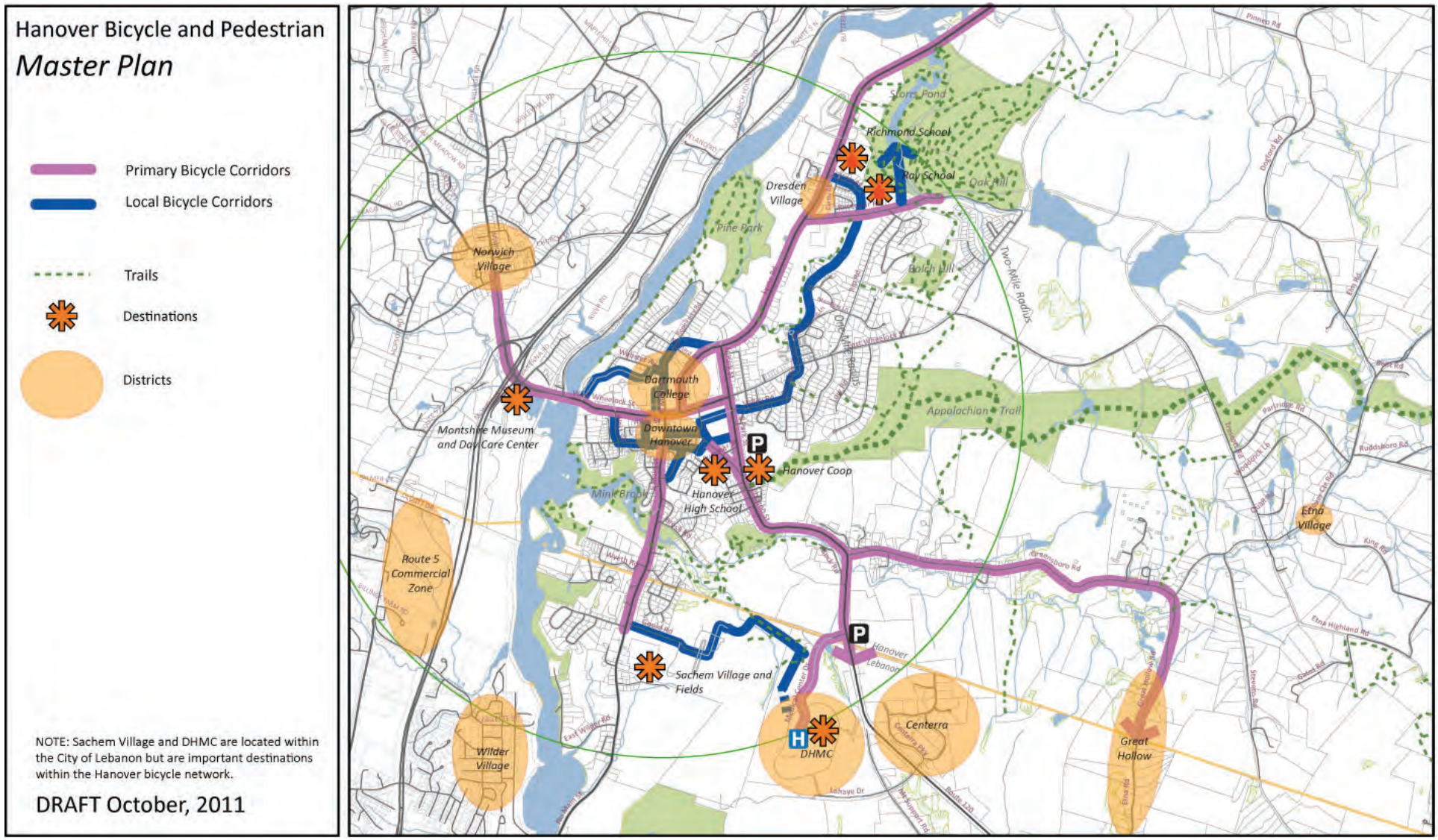


Figure 8: Bicycle Master Plan

pleasing for walking and bicycling, and provides a connection into the heart of the campus and downtown Hanover via North Main Street.

West Wheelock Street. Wheelock Street from the Ledyard Bridge to Park Street is a major bicycle corridor and popular bike route for recreational and commuter bicyclists. Bike lanes were put in place from the Ledyard Bridge west into the center of Norwich, Vermont, which has led to increased bicycle commuting on this corridor. Of the 8 collisions on this stretch of West Wheelock Street, six were the result of vehicles turning into driveways or streets and colliding with an oncoming bicycle; of these accidents five were in the westbound (downhill) direction where bicycles were traveling fast and to the right of cars. One accident was the result of a bike veering into traffic possibly to avoid obstacles at the edge of the road and one was the result of a bicyclist riding on a sidewalk and not seen by the motor vehicle.

The first step to improve this route for bike involves making bikes more visible and expected along West Wheelock Street through bike route signage ('Yield to Bikes') and stencils in the bike lanes.

On the westbound, or downhill direction, bicyclists are traveling at speeds commensurate with cars, bicyclist may wish to 'take the lane' and ride with vehicles, rather than to the right of cars where they are not expected by turning vehicles. Signage indicating that bikes are allowed full use of the lane should be installed to inform motorists to expect bikes in the travel lane. This sign would raise the visibility of bikes in the corridor as well.

At Thayer Drive, which is a focus of accidents as well as Boathouse Drive, the bike lane should be dashed through the intersections to demarcate the bike lane and increase its visual prominence at these conflict points.

For the eastbound or uphill direction, marked bike lanes should extend from the Ledyard Bridge up to Main Street. While there is signed bike route that diverts bicyclists to West Street, many cyclists head straight up the hill, depending on their destination. Marked bike lanes would help to raise the awareness of drivers to expect bicycles on the street.

MUTCD R4-11

Constraint: West Wheelock Street from School Street to Main Street is a constrained right of way. At this location, on-street parking exists on the north side of the street and traffic is generally slow due to a signalized intersection and Main and Wheelock Street. There are a couple of options to consider here: full bike lanes in both directions, including a 'through bike lane' between the right turn pocket and the through lane in the east bound direction, or a lane in the East bound direction and a sharrow in the west bound direction. This should be evaluated further.

East Wheelock Street. East Wheelock Street is heavily used by bicyclists. The street connects the core of the Dartmouth campus to housing and the campus athletic complex. Along East Wheelock Street bicyclists use the street and sidewalks extensively and often ride without helmets. The East Wheelock street streetscape is very attractive and traffic along the street, while often heavy, is slow moving. There is parking on the south side of the street from College to Park Street. Given the volume of both cars and bikes on this roadway, the number of bike crashes is remarkably low, and are clustered at intersections with College and Crosby Streets. One incident was attributed to a bicyclist on the sidewalk at College Street, and two crashes at Crosby Street involved motorists not seeing bicyclists.

In the short term, there is adequate space for a striped bike lane in the west bound direction; and sharrows are appropriate in the east bound direction from College Street to Park Street to guide bicyclists out of the door zone.

In the long term, East Wheelock Street should be evaluated for a cycle track extending from Main Street to Balch Street. The high level of bicycling along this roadway, a large percentage of whom are college students riding short trips without a helmet, and a limited number of driveways and intersections would make it a good candidate for such a facility.

Park Street. Park Street is a significant link in the bike network, and with the bike lanes slated for summer 2011, it will be significantly improved for bicyclists.

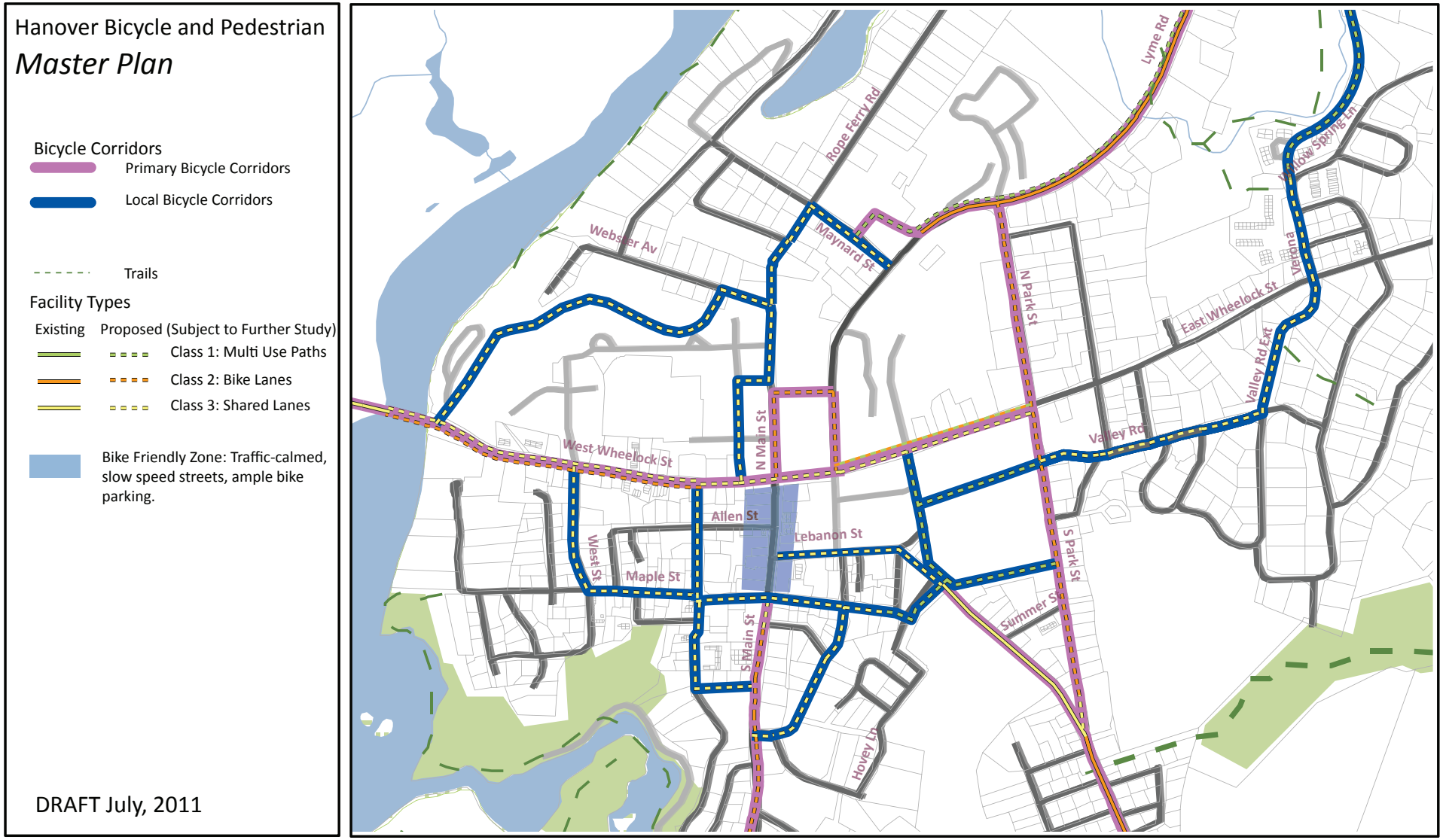


Figure 9: Bicycle Master Plan - Downtown Area

Constraint. The block between Summer Street to Lebanon Street is very constrained. At this location the curb to curb dimension is about 28-feet at its narrowest point, at the Ledyard Bank. The roadway is so constricted along the frontage of the Ledyard Bank that bicyclists are stuck in the queue of cars stopped at the Lebanon / Park intersection.

To address this constraint, Sharrows should be utilized in the travel lanes and or 'Full Use of the Lane' sign (West Wheelock discussion) to designate the shared roadway condition. The Town should evaluate the right of way constraints and work with property owners along this block to relieve the pinch point along this block over the long term.

Lebanon Street. Sharrows should be utilized along Lebanon Street from Main Street to Park Street. One 'dooring' occurred on Lebanon Street, this risk can be addressed by Sharrows.

The intersection of Lebanon and Crosby Street is a focus of bicycle collisions with motor vehicles. Overall, this is a difficult intersection with an extremely long crossing distance created by very wide curb radii. All of these collisions occurred on the north side of Lebanon Street with bicycles riding on the sidewalk (2 crashes) and one riding against traffic, indicating a desire to stay on the north side of the street. As the north side of Lebanon Street is the campus and leads to a cluster of student housing on also on the north side of Lebanon Street, as well as Summer Street, the crashes may indicate a strong desire line to travel in both directions on the north side of Lebanon Street. If this is the case, it is doubtful that either sharrows or bike lanes would convince riders to ride in the street.

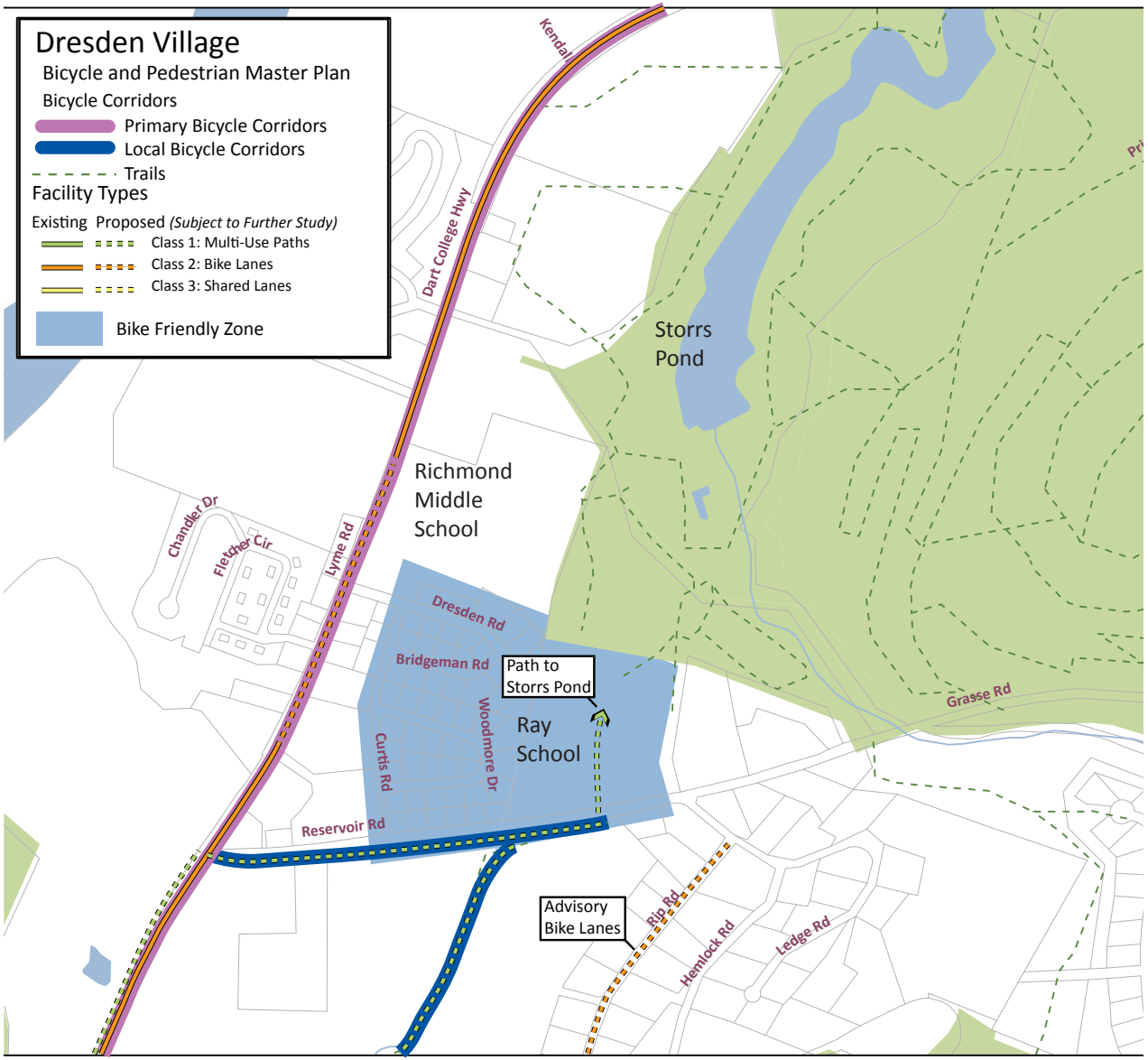


Figure 10: Bicycle Master Plan - Dresden / Storrs Pond area.

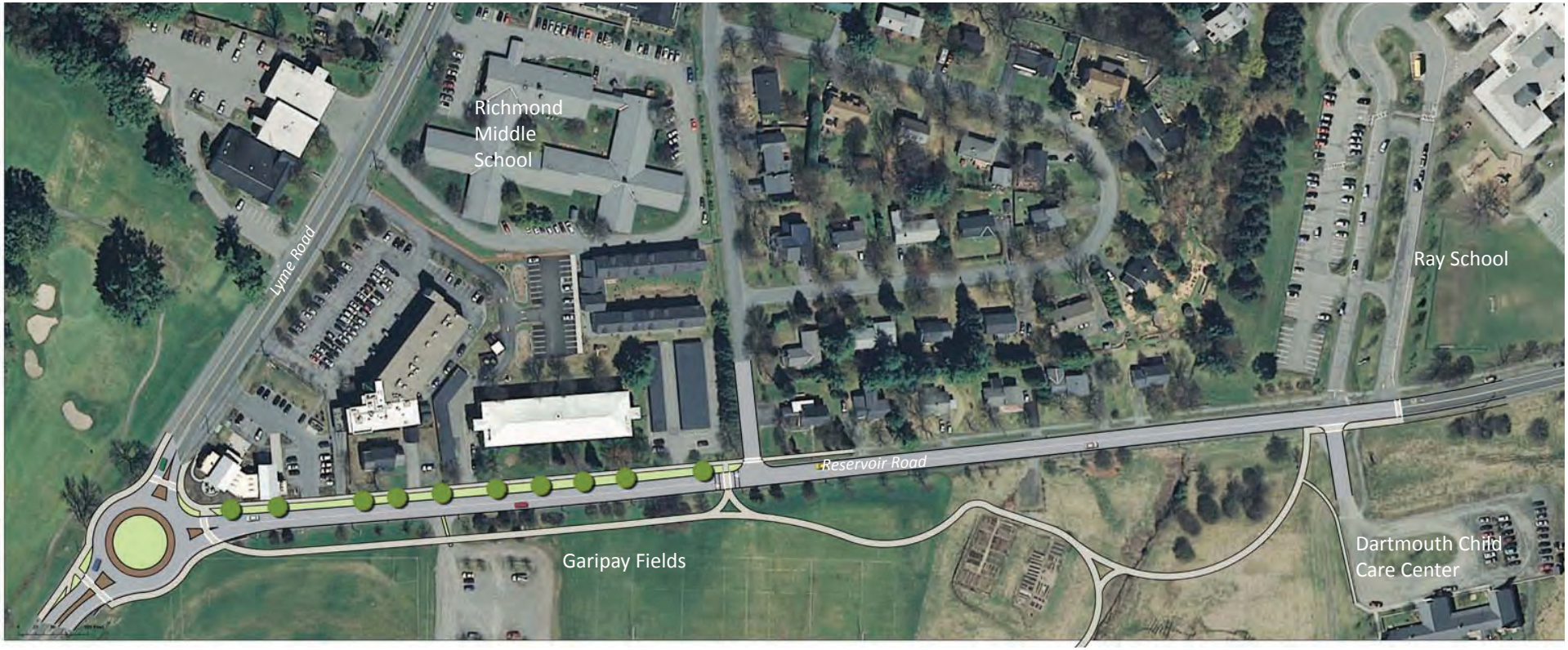


Figure 11: Conceptual Plan for Reservoir Road

Under any condition, the poor geometry of this intersection should be evaluated as it does not work well for cars, pedestrians or bicyclists. A roundabout or tightened up corners to reduce the crossing distance are options to explore. More observation of bicycle and pedestrian activity is needed to understand what would best accommodate pedestrias and bicyclists in this area.

Local Bike Corridors

West/Maple/South Route. As an alternative to the steep hill of West Wheelock Street, the West/Maple Street alternative is a popular route for commuters and recreational cyclists. Sharrows on South Street should be utilized adjacent to the parking lane on the south side of the street.

South Street. South Street is similarly a shared route. The configuration of the end of South Street between the Howe Library and the path to Hovey Lane should be reconfigured to better accommodate bikes and pedestrians. It its current configuration, parking moved to the opposite side of the street and a contra flow bike lane that would allow bikes access to the Hovey Lane path adjacent to the sidewalk would provide a valuable bike and pedestrian connection.

Dartmouth Athletic Complex. Bicycle and pedestrian lanes through the College campus behind Alumni Gym (heavily used now by bike and pedestrians) and behind Leverone Field House/football field can provide direct off street connections between campus destinations, Hanover neighborhoods and Hanover High School, the Howe Library and downtown Hanover. The Town should work with the College to explore the option of a linkage behind Leverone Field House and the football stadium.

Left: Existing sidewalk on Lyme Road. Right: Parkway treatment with bike lanes, street trees and a shared use path.

Valley /Verona / Girl Brook. Valley Road / Verona Road provides a relatively level neighborhood connection to Park Street. As described above, a sidewalk is recommended for Verona Road. Potential traffic calming along Valley and Verona Road and an improved crossing of Wheelock Street to raise awareness of bikes and pedestrian traffic should be considered. The Town should work with neighbors to develop a plan.

A shared use path along Girl Brook which would connect Hanover neighborhoods with the Ray and Richmond Schools and Storrs Pond is a key link in the local bike/ped network and will allow many students to arrive safely at school by bicycle. The corridor is a sewer easement that can be used for public access.

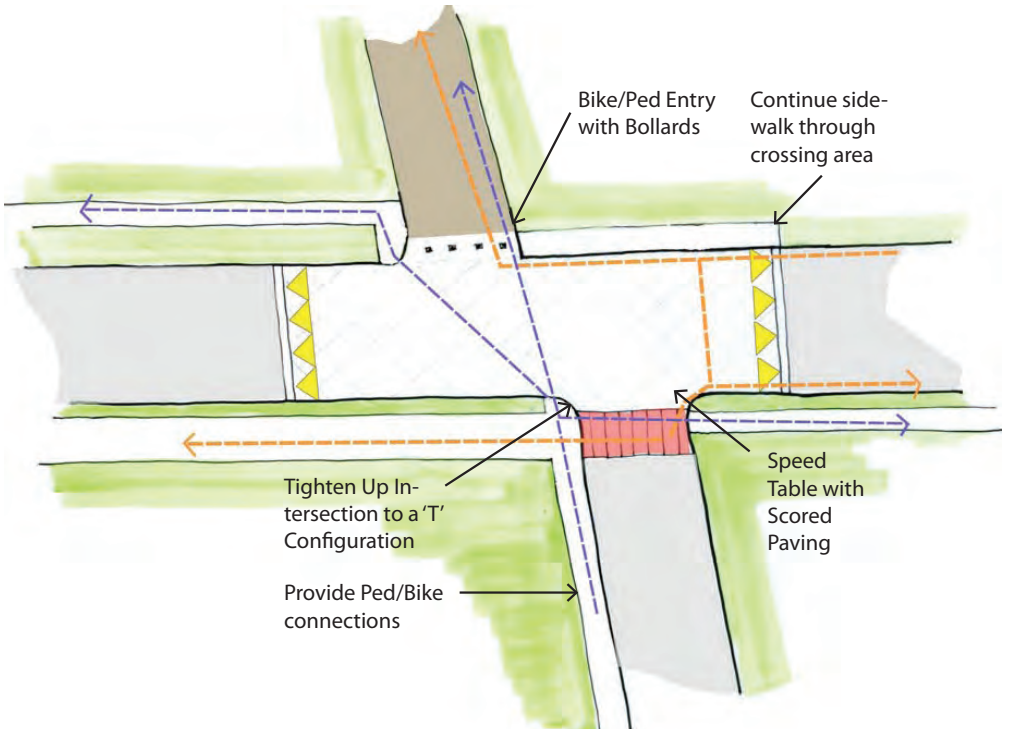
Dresden Village - Lyme Road Area

Missing Sidewalks and Paths

Lyme Road Roundabout at Reservoir Road. The sidewalk here was intended for bicyclists as one option for bicyclists to go through the roundabout (they can also ride with traffic), to avoid riding in the roundabout, however, there is a clear pedestrian desire line to continue walking on the south side of Reservoir Road. As this is an important link to the Ray and Richmond schools, Dartmouth Child Care Center, Garipay Fields and Storrs Pond, and Girl Brook path, a shared use path parallel to Reservoir Road is suggested.

Hemlock / Reservoir Road. Hemlock Street is a major connection to the Ray School from the Rip Road neighborhood. The intersection geometry is designed for fluid movement of cars with wide curb radii and no sidewalks. The crosswalk is a diagonal alignment which lengthens the crossing distance and time pedestrians are in the street. There was a bike accident at this intersection. Reservoir Road west of the intersection is a walking and biking route via the sewer easement to Camp Brook Common. The crossing of Reservoir Road needs to be improved for safer pedestrian use at the entry to the Ray School.

The geometry of the hemlock / Reservoir Road intersection has very wide curb radii, no sidewalks and a long crosswalk at a major entrance to the Ray School.



Conceptual plan for intersection improvements at Hemlock and Reservoir Road which would slow and calm traffic, provide sidewalks, a speed table and direct pedestrian crossings. (ORW Landscape Architects and Planners, "Ray School Entry Design Concepts,' May 2009.

Primary Bicycle Corridors

Lyme Road. Lyme Road provides the northern gateway into Hanover and includes the Ray and Richmond Schools, Garipay recreation fields, and the Dresden Village neighborhood, CRREL, a Coop grocery store and a significant complement of senior housing, apartments and single family housing. In the future, the College's Rivercrest property will add more college housing to the area. With the open space, the elementary and middle schools, senior housing, and future college housing in this area, the goal for the Lyme Road corridor is to provide both bicycle lanes (for confident commuter cyclists) as well as a shared use path for pedestrians, recreational users, and school children. Lyme Road between the roundabout and the Park/College Street intersection can become a 'green parkway' that includes an improved shared-use path with a street tree planting for pedestrians, joggers, less confident bicyclists, roller skiers, in addition to on-street bike lanes.

Constraint: Lyme Road at the Richmond Middle School has a tight cross section that precludes bicycle lanes. For a two-lane road with on-street parking and bike lanes, a minimum of 46 feet is needed; the current curb to curb distance is 40-feet. In the short-term, Sharrows should be used on this stretch of road to guide bicycles through the area, and low traffic speed should be established through traffic calming and speed limit enforcement. In the long term, as opportunities arise through road improvements and/or new development, space should be made for bike lanes with on street parking.

Left: Dresden Road closure does not work for bicyclists, particularly in the winter. Right, Bike Boulevard treatment with bollards, stormwater planting allows bicyclists to use the street.

Greensboro Road - Route 120 Area

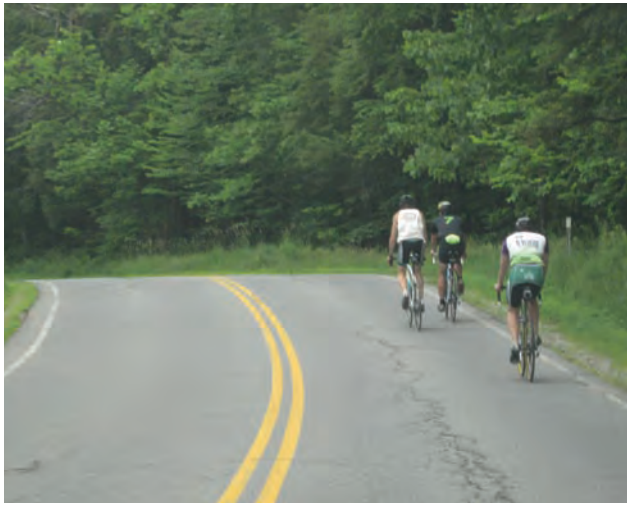
Local Bicycle Corridors

Reservoir Road/ Dresden Road. Special consideration should be given to Reservoir Road / Dresden Road area because of the schools. Dresden Road is a ready-made Bike Boulevard as a street with restricted traffic and a linkage between the schools. Modification of the fence between the Richmond Middle School and Dresden Road is needed to allow bicycle traffic, while still closing off car traffic. Dresden Road at this location seems like an opportunity for a demonstration green street stormwater planting that can perhaps be developed in conjunction with environmental science classes at the Richmond and/or Ray Schools.

Missing Sidewalks and Paths, Primary Bike Routes and Crossings

Lebanon Street from Greensboro Road to Buck Road. There are currently no pedestrian facilities provided to the numerous land uses along Buck Road. In addition, the Gile Hill housing complex has a direct pedestrian connection to Buck Road. The Town of Hanover's permit for Gile Hill requires the developer to provide a pedestrian facility prior to occupancy of the last unit; however it is unclear when this may occur. Along this road a 'lane drop' is recommended which would allow the development of a shared use path and bike lane in the southbound direction in place of the second travel lane. A preliminary traffic engineering analysis of this concept using current data from the Town of Hanover indicates that a lane drop is feasible and would have little effect on traffic operations and congestion. The lane drop would greatly increase pedestrian and bicycle circulation and safety, and would allow the construction of a high quality path and bike lane along this important route.

Beyond Buck Road, it appears to be possible to extend the path along a low spot to the west of the road, behind the commercial center on Medical Center Drive, and tie into the bike path to DHMC. Bike lanes should be maintained along the length of Route 120, however, for non-DHMC bound traffic.



Top: Bicyclists on Greensboro Road. Clearly 'strong and confident' riders.

Providing a two-way facility along the west side of Route 120 would provide an attractive facility that connects to a major destination.

The intersection of Greensboro Road and Lebanon Street / Route 120 is controlled by a signal operated by NHDOT. The signal does not include any accommodation for pedestrians or bicyclists.

With a lane drop, there is also the possibility to improve the transit stop at Greensboro Road to a location where pedestrians could cross the street via a signalized intersection. Covered bike racks at this location could enhance the bus stop here as a neighborhood transportation hub.

Etna Village. Etna's rural village center includes a focus community uses, including a store, public library, and post office, that should be connected by safe walkways and crossings. Traffic calming would be an effective way to improve pedestrian safety by reducing traffic speeds. Etna Road in this area, however, is under jurisdiction of the NHDOT and will require their approval for this change.

Lebanon Street/NH Route 120. Bike lanes are currently in place along this route over 'Sand Hill.' Due to the curve in the road, and turning lanes at the intersection with Park Street, the bike lanes gets 'pinched' by vehicles along the route. Options should be investigated to get extra width for the bike lanes at these points.

Greensboro Road. Greensboro is a two-lane semi-rural road that is popular for commuting and recreational biking and provides access from Hanover to Great Hollow Road/ Etna Road employers and from Etna to DHMC and greater Hanover. Greensboro Road is under the jurisdiction of the NHDOT. The road right of way is complicated as the road is very old. In addition to bicyclists, pedestrians are also forced to walk along a very narrow strip of land adjacent to the roadway. Ideally a shared use path would serve the area well, as there is no off-road pedestrian or bicycle accommodation for this neighborhood. This topic should be the focus of a separate planning effort developed in concert with neighborhood participation.

South Main Street - Mink Brook Area

Crossings

Brook Road - Mink Brook. There is a strong desire line for both pedestrians and bicyclists to travel along South Main Street / NH Route 10 from Sachem Village to downtown and the Dartmouth campus. Sachem Village is campus housing and the residents are likely to be more inclined to walk or ride the bus for a number of reasons, including parking limitations in town.

Etna Village in front of the Town Library.

At Brook Road, there is an entrance to the Mink Brook trail which is a popular trail due to its proximity to downtown and nearby neighborhoods. Pedestrian and bicycle activity should be observed in this area and a plan for safe pedestrian accommodation developed. This location is outside of the Urban Compact, so the road is under the jurisdiction of the NHDOT.

Primary Bicycle Corridor

South Main Street / NH Route 10. Another very significant gateway to Hanover and Dartmouth College that is heavily used by bicyclists is South Main Street / Route 10. This route connects Sachem Village (College housing) and southern Hanover neighborhoods to town. The area around Granger Circle and Brook Road is particularly narrow, with essentially no shoulder room; however, right of way may exist. Hanover should work with NHDOT and the City of Lebanon to establish bike lanes along South Main Street from Sachem Village to Downtown Hanover.

Figure 12: Conceptual plan for the Route 120/Lebanon St/Greensboro Rd Intersection.

A Shared Use Path and bike lane on Route 120 south of Greensboro Road will provide a needed connection for pedestrians and bicyclists from Hanover to Buck Road Medical Center Drive and Gile Hill Housing.

Bottom: Pinch point at South Main Street near Granger Circle.

Sachem Village to DHMC. Although outside the jurisdiction of Hanover, a bike/ped path between Sachem Village and DHMC is strongly encouraged. Such a path would greatly improve commuting for graduate student and staff residents at Sachem Village that must travel to DHMC. With the current circulation system one must travel through downtown Hanover, Lebanon Street and Route 120 to get to DHMC. The efficiency of a bike / pedestrian path along this route would be a strong encouragement to walk or bike this route.

Education

The importance of education for safe pedestrian and bicycle transportation cannot be overstated. Sharing the road safely requires all users to anticipate the actions of the others, so that conflicts and accidents can be avoided. Education must extend to all roadway users, including vehicle drivers, as many drivers are not aware of either the laws or how they can safely share the road with bicyclists and pedestrians.

One clear opportunity for bicycle education can be realized through town recreation programs, which could ideally offer bicycle safety classes for riders of all ages and abilities. While the focus should be on safe bicycling, it should also include an understanding of the applicable laws, and ideally the Hanover Police should be involved in the discussion.

School programs are another possibility. Bicycle Rodeos, school-based bicycle educators can provide education programs targeted to school-aged bicyclists.

Dartmouth College should be encouraged to provide bicycle education and outreach programs to the college community as Dartmouth students, faculty and staff likely make up a large percentage of the Town's bicycling public.

Education outreach to motorists is another important avenue. As bicycling becomes more popular, informational outreach to drivers regarding bicycle and driver protocol for negotiating around bicyclists should be undertaken. Outreach should emphasize the benefits of a bicycling public, including reducing congestion, parking demand, improving the environment and public health. Another option, enclosing the NHDOT's 'Don't be a Road Hog/Road Warrior' brochure could be enclosed with vehicle registration.

Finally, the Hanover Bicycle and Pedestrian Committee could provide information on their website that will allow visitors to understand safe bicycling, and laws, and the availability of classes. In addition, a blog or chat room on bicycling issues could be helpful for both riders and town officials, especially Police, to share concerns about safe bicycling.

Enforcement

Enforcement should be a component of a successful walkable and bikable community. It should clearly be tied with education, so that drivers and riders are aware of the laws that exist. The town should also review any local ordinances, and adjust as needed to reflect the town's goals. One of the most important enforcement provisions that can improve safety for bicyclists and pedestrians is traffic speed enforcement.

One of the best measures here is to develop appropriate infrastructure that meets the needs of bicyclists and pedestrians and allows them to walk and drive lawfully.

Encouragement

For bicycling to be truly 'legitimized' as a mode of transportation, a number of actions can be taken to encourage bicycling by its incorporation into the community. There are a number of steps that can be taken to welcome bicyclists into a community, and make them feel at the center of things rather than a fringe group.

Events. The town should sponsor or support events such as Bike to School or Bike to Work days, that highlight the potential and enjoyment of bicycling for transportation. Group bike rides or tours will get more riders comfortable on their bikes, and therefore more likely to take up bicycling as a means of transportation, rather than a purely recreational activity.

Ancillary Facilities. Bicyclists needs are quite different from car drivers once they arrive safely on the bike network, the following additional resources will provide further encouragement for biking as transportation.

Bike Parking

Adequate bike parking is a critical element of the bike transportation system. The Association of Pedestrian and Bicycle Professionals publishes a comprehensive set of guidelines for bike parking which answers common questions about bike rack design and layout, as well as recommendations for bike parking standards by land use. These guidelines are extremely valuable and are included in the Appendix. The following discussion represents excerpts from that larger report (Association of Pedestrian and Bicycle Professionals, *Bike Parking Guidelines, 2nd Edition*, 2010):

'Why is Bicycle Parking Important?

One of the most common obstacles for bicyclists is the lack of bicycle parking at their destination. At the most basic level, bicycle parking encourages people to ride, but it also has some specific benefits, even for non-cyclists:

- *Bicycle parking is good for business*. Bicycle racks provide additional parking spaces which customers can use to patronize local businesses. Bicycle racks not only invite cyclists in, but they announce to potential cyclists and non-cyclists customers alike that the business supports sustainable values, an increasingly important factor for many consumers.' Bicyclists are more likely to shop locally, choosing local shops over big box stores.
- *Designated, well-designed parking promotes a more orderly streetscape and preserves the pedestrian right of way*:
    - It presents a more orderly appearance for buildings.
    - It prevents damage to trees and street furniture.
    - It keeps bicycles from falling over and blocking the sidewalk.
- *Bicycle parking helps legitimize cycling as a transportation mode by providing parking opportunities equal to motorized modes*.

Short Term versus Long Term Bike Parking

'Bike parking falls into two categories: short term and long term. Long term parking (defined as parking for more than two hours) includes sheltered or enclosed parking in a secured location. This may include sheltered bike rack, lockers, or a 'bike station.' The need for long-term parking is typically associated with residential complexes, workplaces and transit stations.

Bike Racks

The design of bike racks varies widely; some are functional, while others are not. The APBP recommends a bicycle rack that:

Top: Wave style rack at Howe Library.
Bottom: 'Toast style rack at Richmond School on a late spring day.

- Supports the bicycle in at least two places, preventing it from falling over.
- Allows locking of the frame and one or both wheels with a U lock.
- Is securely anchored to the ground.

Cargo bike parked at the Hanover Coop.

- Resists cutting, rusting and bending or deformation.

There are a host of other considerations, but the bottom line is that the 'Inverted U' and 'Post and Ring' style racks meet all of the design criteria identified in the guide. 'Comb,' 'Wave' and 'Toast' style racks are not recommended primarily because they do not support the bicycle in two places which can cause the bike to tip over, bend the front wheel and do not or enable the frame to be properly secured.

Above, Inverted 'U' style bike rack; right, post and ring style rack.

Table 2 presents APBP's sample bicycle parking requirements for Urbanized or High Mode Share Areas. New bike parking should be required of new development, not unlike requirements for car parking.

There is a dearth of parking in some areas of Hanover, most notable to 'old' parts of the downtown in the vicinity of Main and Lebanon Streets. New bike racks, especially covered racks and lockers are needed. Locations to consider include the vacant lot on Main Street (next to the Ledyard Bank, near Lebanon Street near Hanover Park and Spaulding entrances, space within the parking garage, near the Dartmouth Coach stop at the Hanover Inn. This is an area where the HPBAC can help by identifying existing racks and potential locations for new racks.

Showers. Bike commuting often requires wearing a different set of clothes while riding than while working. In addition, riding during warm or rainy weather makes access to a shower at or near the worksite important. Dartmouth College employees may use the showers at the Alumni Gym if they bicycle to work, this is a nice incentive. For Hanover employees, perhaps a bike commuter benefit that allows showering at the Black Center would provide an incentive for bike commuters.

Bike Sharing Program. There is an opportunity to work with the College to develop a low-cost bicycle sharing program for in-town use. Using refurbished bikes collected by the college, with well placed stations at within town, and at the Thompson and Dewy Lots, could help to reduce parking demand in the center of town. Bike sharing would be particularly attractive with a developed bike infrastructure system.

Maps. Bike maps which provide route information and locations for bicyclists needs would assist local and visiting bicyclists.

Hanover Bike and Pedestrian Advisory Committee. The Committee plays an important role in encouraging cycling and walking. The Committee should continue these efforts by:

- Collecting Pedestrian and Bicycle Counts
- Monitoring Accident Reports
- Increasing Awareness through Events
- Maintaining a Blog and Website for Public Input
- Plan Revisions and Updates

- Review of proposed development and Public Works projects from a pedestrian and bicyclists point of view. Site plans should include an understanding of vehicular, pedestrian, bicycle and transit access and the relationship of the proposed project to the proposed sidewalk, path, bikeway and transit system.

Land Use Policy

Hanover's land use policies are generally quite enlightened in terms of providing for pedestrian access and safety as new developments are designed and approved. However, there are some additional areas that should be improved upon in future updates of development ordinances.

- Provide an outstanding pedestrian environment, especially in downtown. All developments in the pedestrian cores of the Hanover (downtown/college, Dresden village, Etna) should provide a friendly face to the street rather than blank walls and provide direct pedestrian routes.

- Street design guidelines should be established for the major streets and roads that sets the framework for new development, and how it will address the street. The developers would essentially be required to implement these guidelines along their frontage.

- Multi-modal Transportation Considerations for New Development-While currently all major developments are analyzed in great detail for the traffic impacts, a similar focus should be placed on pedestrian and bicycle accessibility and safety. The ordinances should identify the appropriate balance between vehicle operations and bicycle and pedestrian safety, and this may alter among the different contexts within the town. For example, in downtown priority may be on improving the pedestrian environment rather than providing an extra traffic turning lane that would improve vehicle operations.

Table 2: Sample Bike Parking Requirements (Source: Association of Pedestrian and Bike Professionals)

SAMPLE BICYCLE PARKING REQUIREMENTS – URBANIZED OR HIGH MODE SHARE AREAS

The following bicycle parking requirements have been scaled to reflect the increased bicycle parking requirements of communities which are densely developed, more urbanized, or which have higher levels of bicycle use.

Residential

Type of Activity	Long-term Bicycle Parking Requirement	Short-term Bicycle Parking Requirement
Single family dwelling	No spaces required.	No spaces required.
Multifamily dwelling		
a) With private garage for each unit*	No spaces required.	0.10 spaces for each bedroom. Minimum is 2 spaces.
b) Without private garage for each unit	0.5 spaces for each bedroom. Minimum is 2 spaces.	0.10 spaces for each bedroom. Minimum is 2 spaces.
c) Senior Housing	0.5 spaces for each bedroom. Minimum is 2 spaces.	0.10 spaces for each bedroom. Minimum is 2 spaces.

*A private locked storage unit may be considered as a private garage if a bicycle can fit into it.

Civic: Cultural/Recreational

Type of Activity	Long-term Bicycle Parking Requirement	Short-term Bicycle Parking Requirement
Non-assembly cultural (library, government buildings, etc.)	1.5 spaces for each 10 employees. Minimum requirement is 2 spaces.	1 space for each 8,000 s.f. of floor area. Minimum requirement is 2 spaces.
Assembly (church, theaters, stadiums, parks, beaches, etc.)	1.5 spaces for each 20 employees. Minimum requirement is 2 spaces.	Spaces for 5% of maximum expected daily attendance.
Health care/hospitals	1.5 spaces for each 20 employees or one space for each 50,000 s.f. of floor area, whichever is greater. Minimum is 2 spaces.	1 space for each 20,000 s.f. of floor area. Minimum is 2 spaces.
Education		
a) Public, parochial, and private day-care centers for 15 or more children	1.5 spaces for each 20 employees. Minimum is 2 spaces.	1 space for each 20 students of planned capacity. Minimum is 2 spaces.
b) Public parochial, and private nursery schools, kindergartens, and elementary schools (1-3)	1.5 spaces for each 10 employees. Minimum requirement is 2 spaces.	1.5 spaces for each 20 students of planned capacity. Minimum requirement is 2 spaces.
c) Public parochial, and elementary (4-6), junior high and high schools	1.5 spaces for each 10 employees plus 1.5 spaces for each 20 students of planned capacity. Minimum requirement is 2 spaces.	1.5 spaces for each 20 students of planned capacity. Minimum requirement is 2 spaces.
d) Colleges and universities	1.5 spaces for each 10 employees plus 1 space for each 10 students of planned capacity; or 1 space for each 20,000 s.f. of floor area, whichever is greater.	1 space for each 10 students of planned capacity. Minimum requirement is 2 spaces.
Rail/bus terminals and stations/ airports	Spaces for 7% of projected a.m. peak period daily ridership.	Spaces for 2% of a.m. peak period daily ridership.

Commercial

Commercial Activity	Long-term Bicycle Parking Requirement	Short-term Bicycle Parking Requirement
Retail		
General food sales or groceries	1 space for each 10,000 s.f. of floor area. Minimum requirement is 2 spaces.	1 space for each 2,000 s.f. of floor area. Minimum requirement is 2 spaces.
General retail	1 space for each 10,000 s.f. of floor area. Minimum requirement is 2 spaces.	1 space for each 5,000 s.f. of floor area. Minimum requirement is 2 spaces.
Office	1.5 spaces for each 10,000 s.f. of floor area. Minimum requirement is 2 spaces.	1 space for each 20,000 s.f. of floor area. Minimum requirement is 2 spaces.
Auto Related		
Automotive sales, rental, and delivery Automotive servicing Automotive repair and cleaning	1 space for each 10,000 s.f. of floor area. Minimum requirement is 2 spaces.	1 space for each 20,000 s.f. of floor area. Minimum requirement is 2 spaces.
Off-street parking lots and garages available to the general public either without charge or on a fee basis	1 space for each 20 automobile spaces. Minimum requirement is 2 spaces. Unattended surface parking lots excepted.	Minimum of 6 spaces or 1 per 10 auto spaces. Unattended surface parking lots excepted.

Industrial/Manufacturing

Type of Activity	Long-Term Bicycle Parking Requirement	Short-Term Bicycle Parking Requirement
Manufacturing and production	1 space for each 12,000 s.f. of floor area. Minimum requirement is 2 spaces.	Number of spaces to be prescribed by the Director of City Planning. Consider minimum of 2 spaces at each public building entrance.

DEFINITIONS

Policy[1]: A specific statement of principle or of guiding actions that implies clear commitment but is not mandatory; a general direction that a governmental agency sets to follow in order to meet its goals and objectives before undertaking an action program [Source: *A Glossary of Zoning, Development, and Planning Terms*, American Planning Association, Planning Advisory Service Report Number 491/492]. Policies are the core principles which requirements, regulations and codes are designed to enforce.

Requirement: Something needed or necessary; a demand [Webster's Dictionary]. While some general requirements may be advisory in nature, they can be used more specifically by local agencies to enforce policy with regard to a particular project. In this case they would become mandatory.

Code[2]: Collection of laws [Webster's Dictionary]. As with other development requirements, codes governing bicycle parking are usually legislated by the local body of elected officials from a city, town or county. Codes contain regulations which are applied generally to enforce policy.

Regulation[3]: A rule or order prescribed for managing government [Source: *A Glossary of Zoning, Development, and Planning Terms*, American Planning Association, Planning Advisory Service Report Number 491/492]. Regulations are specific, legislated elements of a code, utilized to enforce policy.

[1] Advisory [2] Mandatory [3] Mandatory